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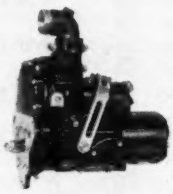

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Briefing for November

"Let's take some of the blood and thunder out of our aviation stories." So says the Editor in suggesting that before aviation becomes labeled as a "merchant of death" industry by political opportunists, the people should be reminded that this woefully unprepared nation staved off immediate defeat through its diminutive but remarkably employed air power, and that it will achieve victory at a cost, in American lives, inversely proportional to the aviation industry's production. The editorial, Headlines—Or Education?, on page 111 is a timely guide to sound public relations.

James G. Ray, vice-president of Southwest Airways, a real aviation veteran and a successful operator of feeder airlines, has the practical experience to give a realistic appraisal of feeder service prospects. Turn to page 116 for his thorough discussion of The Feeder Airlines' Place in Postwar America.

"Have you a little helicopter in your home? It's the newest thing for dishwashing, fishing, lawn-mowing—and incidentally, it's a flying machine, too! Get one for Junior instead of a Kiddie Kar!" Thus is heralded the helicopter—and just as easily may aviation progress be retarded. Read what Lou Leavitt has to say on page 114. And then, for heaven's sake, Let's Be Calm About the Helicopter.

The "glider program" has had its ups and downs, but the fabrication of gliders has been a spectacular achievement—and it is still in full swing. How eleven California manufacturers with varied experience pooled their equipment to turn out CG-4A gliders fast and efficiently is a production story without which the record of American ingenuity would stand incomplete. Otto W. Timm describes the Associate Producers Plan on page 121.

Notice to Aviation Suppliers

If you were not included in AVIATION's Annual Directory for 1943, please write now for necessary forms for inclusion in the 1944 Directory.

Every successful development in simplified controls represents a milestone in aviation progress. The Simmonds automatic power plant control is notable in this category. It is described in detail beginning on page 132.

From the Alcoa laboratories comes another invaluable study, this time with respect to head cracks in 24ST rivets. Data on strength, corrosion resistance, heat treatments, and aging comprise this latest guide for designers and fabricators. Page 139.

Trouble with icing is its erratic formation. To combat it, de-icing equipment must be flexible both in design and control. The new Bendix manifold-solenoid system with electronic control, a marked step forward in this hard battle, is described on page 144.

The American aviation industry has astonished the world with its aircraft production rate. Efficient line assembly methods are responsible, and a basic discussion of the underlying principles of these methods are set forth in Aircraft Production Analysis beginning on page 148.

In concise form is presented data for analyzing members with varying moments of inertia on page 153.

Electric power is the lifeblood of our aircraft plants. An electrical distribution system must be highly dependable to maintain production. A model plant, installed at one of Wright Aeronautical's Ohio plants, is described on page 157.

"For the want of a nail —" just doesn't happen at Consolidated Vultee. "Little CV" is a plant-within-a-plant which can salvage, repair, or build anything—to prevent production jams before they begin. See page 161.

Engineers just can't be bought anymore —so they must be built. Vega's production line to make them to specifications is described on page 167.

Americans have shouted loudly about pioneering airways which now stand the military in good stead. In thinking about what's what in the postwar airways scramble, don't overlook the fact that pioneers have flown under other flags. See page 196.

Down the Years in AVIATION'S Log

25 Years Ago (1918)—To reduce fatalities resulting from defective workmanship in planes and plane engines, government inspectors will be required in the future to make initial trips in machines they have passed . . . Capt. R. W. Schroeder, A.S., sets new altitude record of 29,800 ft. in Bristol two-seater powered with 300 hp. Hispano-Suiza engines. . . . Announcement is made by Post Office that proposed air-mail route between New York and Chicago will be inaugurated in December.

15 Years Ago (1928)—Mussolini gives permission for U.S. production of Savoia-Marchetti airplanes. . . .Long Island Aviation Country Club, Inc., establishes first of planned nationwide chain. . . . Capt. C. B. D. Collyer flies Lockheed *Vega* (the *Yankee Doodle*) coast-to-coast in 21 hr. 51 min. beating record by 1 hr. 59 min. . . . Curtiss sells Chile 18 observation and 9 pursuit planes. . . . Nine Cincinnati newspaper men take aviation course to improve understanding of subject. . . . PAA announces new air-rail service, New York to Havana. . . .

10 Years Ago (1933)—Congress appropriates $3,300,000,000 for airport building by PWA. . . . Germany substitutes fast freight planes for freight trains to East Prussia. . . . Lt.-Col. Casinelli, Italian Army, flies 100 km. at 393 mph. . . . French aviator, Gustave Lemoin, makes altitude record of 44,822 ft. . . . Soviet balloon *Stratostat U.S.S.R.* rises to 62,300 ft. (11.8 mi.). . . . Wedell flies 615 mi. (N.Y.C. to Cincinnati) in 2 hr. 40 min. . . . Flight Lt. Chas. T. P. Ulm flies from England to Australia in 6 days 18 hr. . . . First flying sleeper lands in Newark from Atlanta. . . . Tractor dealer in New Mexico boosts sales during depression by using airplane. . . . New Guinea goldminers fly in dredge machinery over jungles. . . . Panagra ships 2,000 hp. hydroelectric equipment over 19,000-ft. Andes.

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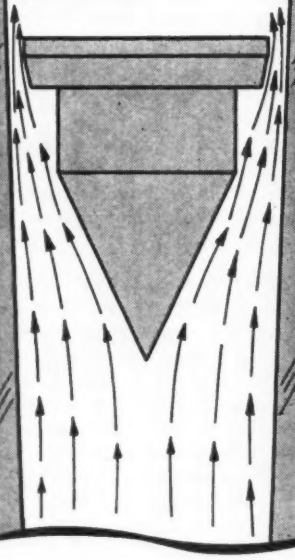

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The rotameter's straight line calibration curve is but one of its many advantages as a flow rate instrument. These advantages are rapidly causing instrument and operating engineers to replace fixed orifice meters by the rotameter in many important metering applications. The full details are told in a comprehensive and highly interesting booklet just printed, entitled "A New Era in Flow Rate Measurement." Large illustrations and a modern cartoon style make it easy and instructive reading. We will gladly send you this pamphlet without obligation—write us if you wish a free copy.

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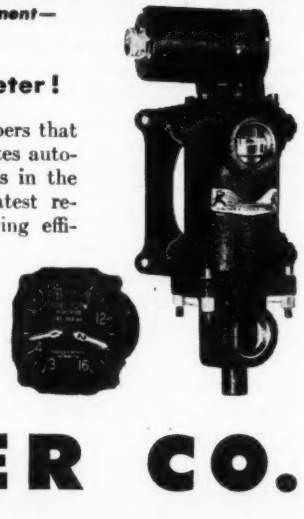

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WHAT IS IT? HOW DOES IT WORK?

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OURS is a free-enterprise economy the chief motivating forces of which are the prospective rewards for effort and risk-taking. Its smooth operation depends: first, on adequate incentives for risk-taking, innovation, and individual effort; and second, on sufficient competition to minimize the need for government regulation and to prevent artificially high prices or wages from being maintained in large segments of the economy. Trouble comes when these incentives and this competition are tampered with or removed.

America was founded by men who had the urge to better themselves and the courage to take a chance. These men uprooted themselves in Europe and braved the unknown. They risked all for freedom. They knew that, to be free, they had to attain economic freedom. Their goal was an economic freedom which permits the private ownership of property, the free choice of jobs, and free entry into entrepreneurial pursuits. Their efforts, therefore, were directed toward individual opportunity with no limit on individual achievement. Their foresight and the endeavors of those who followed them created the world's greatest industrial nation enjoying the highest standards of living.

We can take pride in the knowledge that our country has been the greatest single contributor to the world's physical assets even though we remember that an abundance of natural resources contributed materially to America's economic development. But the fact that our progress has been interrupted, again and again, by depressions which resulted in enormous wastes of our human and material resources is sobering proof that our economic mechanism still is far from perfect.

Our production per man-hour has been increasing at the rate of 2½% per year. Improved machines and greater efficiency have more than tripled the output per hour of work since 1900. Looking to the future, this annual rise indicates that our production per hour of work will double in the course of the next 25 to 30 years. This means that we can have twice our present volume of goods and services per capita or an equivalent combination of more production and more leisure. In other words, we can further increase the living standards and further decrease the working hours of the American people by further intensifying our industrial efficiency.

This is no idle dream. It can be achieved, and it will be achieved, if only we maintain the essential features of our system of individual enterprise which alone makes possible this near-utopian goal. Intensification of our efficiency, however, means that we can have full employment only if we expand enormously our production, and particularly our production of new goods. We can expand total production only if we have the markets and the demands for the vast output of goods and services made possible by our technological development. To attain these, we will need to venture into new markets, new inventions, and new methods. Such ventures involve risks, and risks will be taken only if there is sufficient prospect of reward.

Let us never lose sight of the fact that the essential features of free enterprise are the prospective rewards for risk-taking as well as for effort.

The evidence is clear that incentive methods of wage payments will boost production. Carefully devised systems of salary payment with large differential inducements for superior performance have been powerful means of raising the standards of managerial accomplishment.

Free enterprise cannot operate effectively unless the wage and salary system offers greater rewards for greater effort. Neither can it operate effectively unless the prospects for profit are sufficient to encourage the employment of resources which otherwise would be kept idle.

Unless the prospects of profit are superior to the prospects of loss, new ventures will not be undertaken and going concerns will not expand or continue long in business. When the hope for profits wanes, employment and production slump; when that hope revives, employment and production recover.

Business initiative must be given every possible in-

ducement in order that maximum employment may be achieved through private enterprise. This involves the removal and avoidance of restrictions on business by government, by labor, and by business itself.

Competition is the life-blood of the free enterprise system. Business and industry must rely upon efficiency rather than upon protection from competition for their survival.

Those government controls which were made necessary during the war by the magnitude of government demands for goods should be lifted at the earliest possible moment. As soon as the danger of inflation has receded, price controls must be removed and profit margins again left free to be determined by market forces. The excess profits tax must be repealed and the burden of other taxes on business profits greatly reduced. Tax laws should be revised so as to permit adequate rewards for assuming risks. The modernizing of anti-trust laws and their vigorous enforcement, not indiscriminate persecution, will be supported by all who really want free enterprise. Such measures will strengthen the incentives to expand old businesses and to start new ventures.

Grants of unlimited monopoly powers to labor unions which enable them, consciously or not, to sabotage the profit incentive in business must be withdrawn. Labor has certain legitimate rights; and in order to preserve them and its freedom, labor must come to realize that its best interests lie in a well functioning, self-disciplined competitive free-enterprise economy.

There must be evolved in the minds of business, labor, and the public a recognition of the need for private business enterprise and a realization that policies which throttle it are harmful not only to businessmen but to workers and consumers as well. Unless we achieve this understanding and avoid needless deterrents to business expansion, we are likely to pay for our folly in the destruction of our free enterprise system.

We cannot tolerate conditions in which special interest groups in business, labor, agriculture, or politics prevent free access to the market by would-be competitors. Such monopolizing of opportunities stifles progress and creates profits or wage rates based on artificial scarcity. In such cases government interference to open the market to all comers is clearly indicated. We must recognize the need for constructive policies by business, labor, and government which will insure the competition necessary for the successful operation of our economy.

Increased government regulation and control of business activities is not conducive to strengthening the virility of private enterprise. Government ownership and operation of productive resources certainly is not to be condoned. The more government rules and regulates business, the less will be the incentive to assume risks and to exercise individual initiative. Government regulation of the detailed operation of industry inhibits progress, is prey to political pressures, and is subject to the human failings of its administrators. *Better far the rough guidance and justice of vigorous, though somewhat imperfect, competition than the uncertainty of arbitrary regulation.*

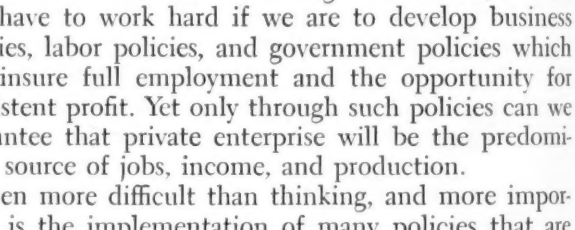
The gravest threats to our competitive system exist in legalized monopolies, such as the N.R.A. once comprised, such as the labor unions and farm groups have recently achieved, such as businessmen themselves have sometimes sought. The power of labor monopolies to encroach on business profits will tend to interfere seriously with the needed flow of new investment. And when any group is strong enough to move the average level of costs as much as the labor groups and the farm groups are able to do, there is good reason to fear that, when we begin to approach high levels of employment and production in time of peace, these groups will induce a price-wage spiral which will waste money incomes on price increases instead of permitting them to draw unemployed resources into production. While the demands of labor for collective bargaining rights and the demands of farmers for protection against the rigors of depression have validity, there can be no reason for excessive grants of power and privilege which threaten to make our system of free enterprise unworkable.

Ours is a complex economic structure. The functions which prices, income, savings, investments, and taxes play in this system are difficult to comprehend.

As I have said before: Thinking is hard work, and we will have to work hard if we are to develop business policies, labor policies, and government policies which will insure full employment and the opportunity for consistent profit. Yet only through such policies can we guarantee that private enterprise will be the predominant source of jobs, income, and production.

Even more difficult than thinking, and more important, is the implementation of many policies that are in the interest of the free enterprise system. Not all measures will satisfy all people. Special interests will have to be subordinated to the total interests of the nation. Sacrifice and vision have been essential to the winning of the war. They will be no less essential to the winning of the peace.

If we can gain recognition of the crucial role of incentives for enterprise, if we stand squarely for competition and against protection or privilege for special interests, and if we bend our efforts to find satisfactory ways and means to prevent large-scale unemployment, we can have the full benefits which only a free enterprise system can produce—in industrial progress, in improved standards of living, and in the preservation of our democratic ways of life.



President, McGraw-Hill Publishing Company, Inc.

Headlines—Or Education?

SINCE ITS EARLIEST BEGINNINGS, the aviation industry has suffered from adverse publicity. Self seeking politicians have utilized its headline value to impress their constituents and create the false belief that they were heaven sent crusaders against the forces of evil. Like the national leader who complained recently because his Congressional appearance was not timed properly to make the morning paper headlines, the professional politician selects his victims on the basis of their headline value. In this aviation qualifies highly.

No group of industrialists have contributed more and been rewarded less than the members of the aircraft industry. In its sincere and commendable efforts to take high profits out of war, Congress has been blinded to the needs of growing industries like aviation to accumulate reserves for research and development—their greatest assets. Under present policies of renegotiation the aviation industry finds itself at a terrific disadvantage in comparison with those industries whose markets are accumulating as the war goes on. Unless these situations are recognized and corrected, the whole future of American aviation and air supremacy is at best uncertain.

And yet those industrialists who are sought out for sacrifice on political altars will include a high proportion of the men whose efforts have been the greatest single factors in the salvation of civilization.

Today, these men are home front heroes in the miracle of production. With public feeling high for air power, the sniping by the politicians stings, but it cannot hurt for long. But tomorrow, as the casualties come limping home, there will be a great revulsion against war. The shouts of victory will not assuage the anguish of bereavement. And as the hysteria of war and our hatred of our enemies begins to fade, the public mind will revolt more and more against the instruments of death. Almost over night the heroes of production can be transformed into *Merchants of Death* engaged in *One Hell of a Business*. It would be a good idea for all of us to read again those books which made such a deep impression on the public after the last war.

THE POSTWAR PILL is bitter for the men who labor day and night to build the untold quantities of instruments of war. But it is best to "take it" now and make some reasonable preparation for the future. The only solution lies in immediate and continuing education of every man, woman, and child in the United States.

The time has come for aircraft manufacturers individually and collectively to take a tip from older and more experienced industrialists whose business it is to create the wherewithal for war. Public relations programs should be planned to educate all segments of the population in the constructive value of the airplane. This does not mean that a manufacturer should not tell the people about his contribution to the war effort. But let's throw away the blood and thunder stories and emphasize the life saving qualities of the airplane.

The best strategist is the one who plans to take an objective with the lowest cost in losses. Already our airplanes have saved thousands of soldiers' lives, and every plane we build and place in action will save more lives in future combat operations. The public should be told and retold this story until each home front fighter is convinced that loved ones on the fields of battle are *safer because of airplanes*.

IT WILL DO MORE GOOD than harm to give your 130,000,000 customers occasional glimpses of the ever-shrinking world. Some manufacturers have done highly creditable work in advertising campaigns in this direction.

But public relations efforts should not stop when the usual instrumentalities of the profession have been fully utilized for constructive education of the people. Aviation manufacturers should study the methods used by old established industrial organizations to familiarize the youth with their accomplishments. What school boy hasn't thrilled at the work and genius of such men as Steinmetz? And through such knowledge comes a deep, enduring appreciation of the company that made his work possible.

This conception of creative public relations goes far beyond anything the aviation industry and many other industries have done so far. It is a costly, long term enterprise and cannot be accomplished over night. It should have been started sooner, but it is not too late to start it now. And if it is done and done well it will do much to divert the efforts of future political opportunists who live by headlines, preferably in morning papers.

Leslie E. Neville

EDITOR

America at War

From plane factory to fighting front is a long process . . . . Germans work hard to stop bombing . . . . Increase noted in production of improved fighters and employment of new weapons . . . . Allies stretch range of fighters for more effective bomber escort . . . . Problem of licking Japs still looms as most formidable of war . . . . International air questions are forced into open.

THOSE IN A POSITION to know the facts of the air war in this period, both military and production men, are surprised at the difficulty and long time required in getting warplanes from factory to combat.

Difference between the total of delivered planes since the first American models, and the total now in use on all fronts, is amazingly high. In other words when you add up planes produced you are surprised at the lesser number in use—a number which, of course, cannot be published.

Some small part of the time lag is chargeable to requirements at modification centers. A great many planes are going through modifications for battle and a great many of them are elaborately changed. In some cases, man-hours put on modifications stack up to thousands per unit. In fact, producers and the armed services have been accused of rushing airplanes through factory lines and adding them into the monthly total to make an impressive production rate, whereas actually the planes are nowhere near ready for action and should not be counted until they are. Though it is highly doubtful that this is done intentionally, the effect is the same: The total of airplanes that comes out of plants is higher than the total ready for war.

Modification time is only one factor, of course. The pipe-line that carries planes from completion in this country to dispersal blinds at the front is a long and tortuous one.

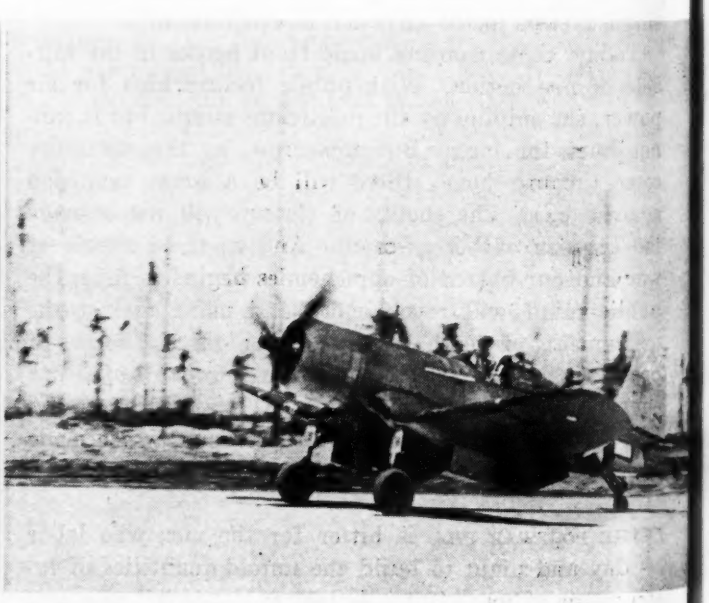
When one considers the number of planes in the hands of squadrons and the number of fronts on which they are deployed one wonders how they can have done so much damage as they have done to the enemy.

Army and Navy are begging for more planes, faster. It is doubtful if they will have enough even on Hitler's judgment day. Airplanes are now number one, two, and three on the war command's priority list. Both services are taking measures to help the industry run the rate up to 10,000 per month by the new year if it is humanly possible.

The Army called a conference in Washington of war industry bosses, labor, and the press. The Navy has just set in motion a new incentive program by which it will try to jack up the fighting spirit of management and workers on the home front.

Behind closed doors, during the Army's conference, war goods producers were told some very disturbing facts about our losses of materials and the punishment our soldiers are taking. The story of our airmen's battle is not what it sounds like in the newspapers. The whole truth cannot be told because the facts would be

Beneath huge clouds of smoke lies wreckage of Germany's second largest fighter plane factory, tucked away (the Nazis thought safely) in a bend of Danube near Austrian border at Regensburg. American *Flying Fortresses* made this long raid in daylight, destroyed more than 140 Nazi fighters in process. (British Combine.)



What can't those Seabees do? A brief 46 hr. after Japs were driven from Munda airfield, this Marine *Corsair* rolled to an easy stop on a "velvet" field restored by hard-working Navy Seabees. Stripped trees in background are mute evidence of furious fight waged at field. (International News.)

One of the war's most perfectly executed airborne troop attacks. American parachute troops land behind well-laid smoke screen in New Guinea to trap 20,000 Japs at Lae. Southwest Pacific Command has established a continuous record of brilliant all-round employment of air power in all of its forms. (International News.)

useful to the enemy. Some of the aircraft company presidents in attendance, who have had more contact with the government than other war manufacturers, said they thought the Army painted the picture a little too dark. But even with some discounting the story is bad enough.

The Germans are now behaving like scared burglars. They are desperate and dangerous. The Luftwaffe is getting a lot of good defense fighter planes. Bomber production was discontinued last December. Nazi laboratories are working frantically to find new weapons and means of destroying our air power. The Germans are especially determined to stop the B-17's and the B-24's which are finding their vital plants and military establishments by daylight. Gen. Arnold says they must not be allowed time to perfect their defenses. Other military observers from overseas say the Germans have a fighting chance of stopping the Allied bombing attack much in the same way that we stopped the German U-boats—by going after them hard with new weapons.

(*Turn to page* 311)

Let's Be Calm About the Helicopter

By LOU LEAVITT

Former Test Pilot at the Pitcairn, Kellett, and Platt-LePage companies and now rotary wing consultant to two major manufacturers.

Overwhelming publicity—much of it not even half-baked—threatens the rotary wing aircraft. A case of "too much and too quick," this trumpeting will speedily ruin the prospects of the craft, says this veteran test pilot—unless the trumpet is muted.

ADVENT of the helicopter has been heralded with a torrent of publicity—a torrent which is fast threatening to become as destructive as that which first awakened public enthusiasm for the autogyro. Why a basically new type of aircraft which has not as yet wholly convinced the airmen and engineers who make their living at aviation should immediately be vaunted as the answer to a housewife's prayer is not very understandable unless it be explained by the American flare for all-out enthusiasm in a new cause.

Lord knows, I am no skeptic where the rotary-wing is concerned. I have spent twelve years in its development and have seen many of its greatest critics become, practically overnight, its staunchest advocates. But I have seen, too, what this type of flash publicity and bandwagonism can do to a sound and logical idea.

The early autogyro had much that might have proven practical and highly advantageous as a flying machine. But it was represented, before its development was even well started, as the be-all and end-all of safe aircraft. It was safe, I grant you. Very few people ever actually got themselves killed in it. But very few people ever actually learned to fly the thing without breaking it up in every nook and cranny of the country-side.

Why? Certainly not because of any basic fault of the machine. Here was an aircraft that would take off and land in the most restricted areas, that could hover or descend almost vertically, that far exceeded in maneuverability anything an airplane could possibly attempt in the slow speed range. But it was advertised as fool-proof—the ultimate solution in aviation for the "man in the street." One advocate even went so far as to proclaim that "in practically any emergency condition it can take care of itself and of the man who flies it." But the attitude of many who flew was that no self-respecting airplane pilot who had spent years perfecting his piloting art was going to demean himself by being seen in such a craft. And those who might have made of it a practical and useful aircraft were quite understandably blinded to its very real values by these exaggerated claims.

Furthermore, as an aircraft it was never a finished product. It never became a finished product largely because the American public never let it become one. The well-nigh hysterical wave of publicity which swept the country also swept the few closely-owned, patent-holding companies with the result that the autogyro was literally tossed into the hands of enthusiasts who lacked even the ability to ride a bicycle. I know, because I tried to train some of them.

Thus the budding industry experimented with road-ability; it worried about the folding of rotor blades to fit into garages; and it tinkered with hydraulic devices and automatic gadgets to appeal to the mind and eye of automobile drivers. In the process it neglected to produce the flying machine that might so easily have been perfected. And the fields that were open to it, the logical and obvious fields of development that were crying their need for just an aircraft, were never given more than a passing thought.

New Public Attitude Needed

Conceivably the autogyro might have been saved by the war. A far-sighted and understanding policy might have done the trick. But in wooing government aid, the autogyro companies found themselves facing a new master, as little versed in true rotary-wing values as the premature publicity that had already proved so damaging. By moving under military surveillance, the autogyro became just another type of airplane, but it was no more comparable to the airplane than it had been to the automobile—except, perhaps, that it was an aircraft.

To expect the perquisites of the airplane, in addition to its own peculiar characteristics, was as fatal in the long run as the earlier policy had been. The 'gyro could not compete with the modern airplane in load-carrying capacity, in speed, or in efficiency. It never had a chance to develop its own field.

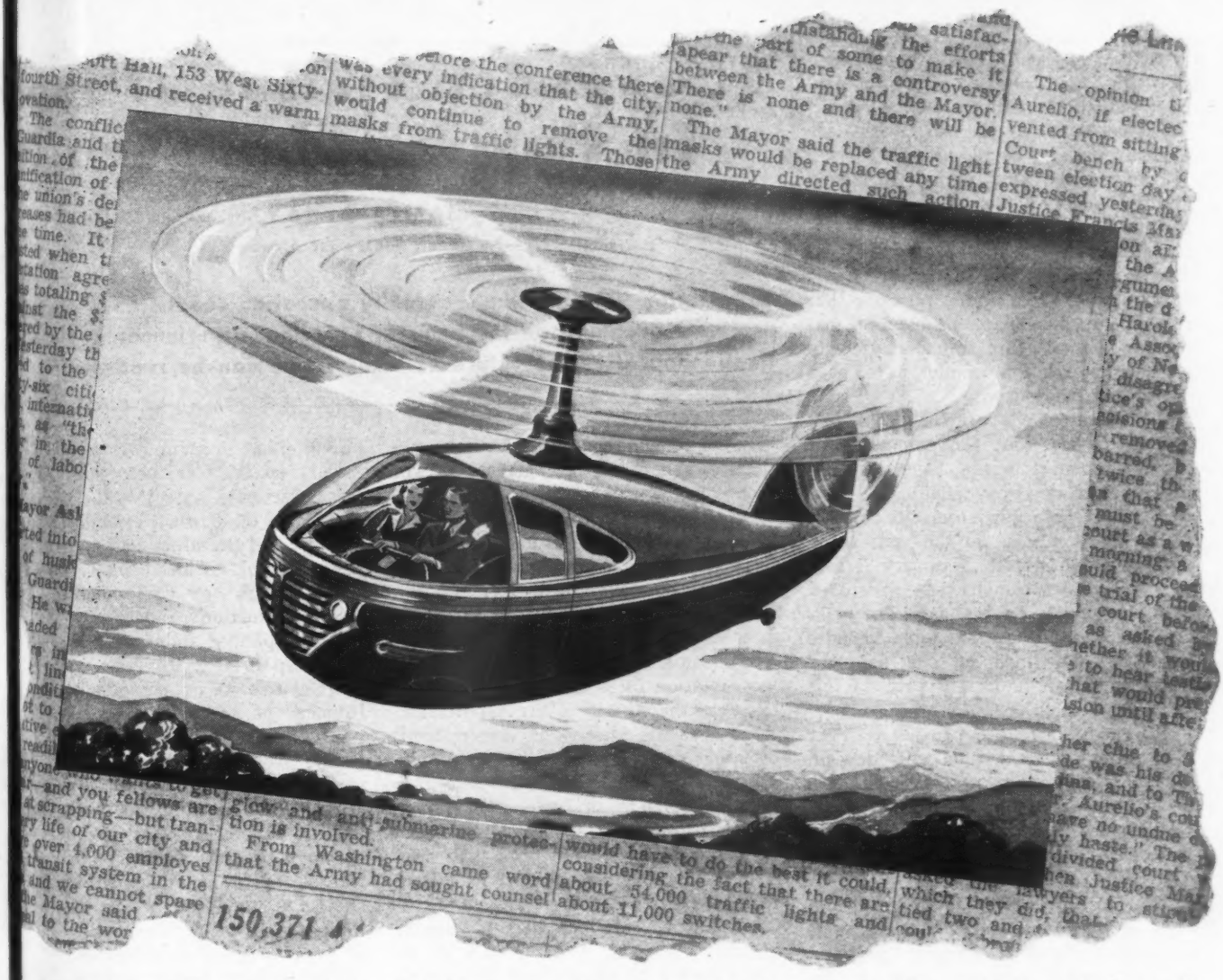
In 1935 I tested, demonstrated, and obtained a Department of Commerce license for a direct-control autogyro, the first of its kind to be so licensed. It was a good ship—maneuverable, easily handled, comfortable to fly. Granted, it was not perfect, but it was a good start toward a worthwhile ideal. What happened to the ideal? Well, somewhere between the "man in the street" and the observation, pursuit, bombardment set-up of the military picture, it got lost. That very ship—eight years later—can still hold its own with any rotary wing aircraft.

This is indeed a sorry picture, but I have dwelt on it because it is so obviously an object lesson. With the passing of the autogyro—obsolete before it ever was perfected; far worse, obsolete before it ever was really *used*—the helicopter comes valiantly into the picture flaunting the same sorry banners. Already we have seen articles about housewives flitting merrily about the sky in one, with pictures of them gassing up at the local filling station. We are told it is the "flivver" of the future. Aircraft companies, vaguely contemplating post-war development, are already receiving deposits from individuals steamed up no end by this new flying idea which, if you would believe feature writers and newspaper columnists, is practically an accomplished fact. And, judging by the number of rotary-wing experts that have suddenly popped up all over the country, the need for a wailing-wall is going to be terrific in a very few years.

But what of the helicopter in the meanwhile? Will it go down, as the autogyro did, under the weight of publicity which patronizes a trend set by people who, in most cases, have never even ridden in an aircraft, much less know the limitations involved?

After all, the helicopter is an aircraft. Let us not lose sight of that significant fact. It is supported by, and dependent upon, the air in which it flies. As an aircraft, it has wonderful and far-reaching possibilities *as an aircraft.* But, as an aircraft, it has far to go before it reaches anything like perfection.

There are many problems still to be solved. Igor Sikorsky has succeeded in solving some of them. More power to him. He has evolved a machine that flies, that is controllable, that shows many of the latent possibilities inherent in this type of aircraft. But I do not believe this ship is the ultimate answer any more than the Wright brothers' first airplane was the ultimate answer to



odern air transportation. And who, in ose days of crude craft, ever dreamed f haling the housewife into the air? Why this intense concentration upon ousewives and men in the street anyay? The rotary-wing was not orig-ally conceived with any such idea in ind. This "family" business has been gged on by misplaced publicity and thusiasm, and it is high time it was rown into the discard where it be-ngs—or at least into the future. The otary-wing deserves better of our ef-rts than these fantastic dreams, for it a means of flight that is needed in viation and needed *now*. It covers a nge of speed and maneuverability ever before open to aircraft, and it up to us to concentrate on that range develop its full usefulness.

The helicopter is needed even more an the autogyro was needed, by vir-ue of its ability to fit, even better than e autogyro, into the fields of endeavor nd achievement open to this type of ircraft. It is needed by the Coast uard for shore patrol, for rescues at a, for the transfer of sick or wounded hore. It is needed by the Depart-ent of Agriculture for insect control, r the spraying of crops and orchards, r the spotting of infestations from e air. It is needed by the Forestry Department for fire spotting, for the placing of personnel and equipment where they will do the most good in fighting large fires, for the direction of fire fighting from the air. It is needed by the farmer. It is needed by the large scale rancher.

And surely it is not necessary to point out how useful it could be to the military services—not as a pursuit ship, or a bomber, or an observation plane, and thereby forced to live up to the airplane standards set for these ships—but for the transfer of personnel behind the lines, for artillery fire control, for courier service. Moreover, if we are set and determined to compare it with the airplane, how about inter-city mail service? Let us give it the break that the airplane got; for the airplane, if you remember, owes much of its early development to the perfecting of this service. The helicopter, too, could reap untold benefits by developing inter-city mail lines, carrying the mail from post office to post office, thus eliminating the present necessity for trucking between airport and post office.

This is no far-off dream of the future, either, for the idea has already been played with, more or less tentatively, perhaps, but with a substantial degree of success. As far back as 1935 I had the privilege of landing the first mail on the post office roof in Philadelphia. The idea caught hold and an airport to post office route was then established with autogyros, though unfortunately the plan was never carried to its logical conclusion of city-to-city short haul mail throughout the country.

These are but a few of the more immediate needs for this type of aircraft. It does not take much imagination to discover more. An aircraft that takes off and lands vertically, that can fly forward, backward, or sideways, or hover stationary, in relation to the ground, does not have to compete with the airplane to find its realm of usefulness, nor does it have to cater to the whims of public fancy to be saleable.

But, as I have tried to point out, the helicopter is far from perfection at the present writing. Nor will it ever attain that perfection until it gets down to cases on the things it can really do. Fortunately, the patent situation does not parallel that of the autogyro, and I firmly believe that the helicopter's future success will be in the hands of the larger aircraft companies which have the facilities and the personnel to exploit its many advantages wisely.

When the helicopter is built to meet

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The Feeder Airline's Place In Postwar America

By JAMES G. RAY,
Vice-President, Southwest Airways

An aviation veteran who's actually operating feeder lines analyzes pertinent problems on the basis of practical experiences and realistically appraises the future services which can be rendered.

IT IS an especially healthy and heartening sign to the entire aviation industry that the subject of feeder airlines has come to the fore with such amazing celerity in recent months.

For had the long period of official and unofficial discussion on international airways continued to hold Washington's attention to the practical exclusion of other types of air transport development, it is quite possible that our equally important problem of extending domestic air transportation to all our population would have been completely overlooked.

There are some who believe that, had there been no war, the expansion of feeder transport would have occurred normally in the early 1940's. Be that as it may, there now seems to be little doubt but that it is on the verge of a long-deserved public discovery. Two new and vital national needs—combined with the already existent need for making direct air service available to more than just one-third of our people—have played an important part in this sudden evolution.

They are: First, to provide postwar employment for the thousands now in all phases of military aviation; and second to find something for our aircraft factories to do to help them through the period of reconversion to a peacetime basis.

That we must solve these two problems is a foregone conclusion; hence, we cannot afford to minimize the effect of any sound program such as the widespread establishment of feeder airlines, which is a step in the right direction.

The end of the present world conflict will bring home thousands of pilots, mechanics, and other technicians who will need jobs. For the sake of future aviation development and progress, it will be desirable to create as many positions as possible in aviation activities for these highly trained men. Aviation can use them just as much as they can use aviation as a source of employment.

It is repetitious to say that, after the war, aviation faces the greatest development in the history of transportation. To assure its successful development, every man will be needed. If those who return from the service are forced to find employment in some other industry, it is probable they never will return to aviation—not to mention the fact they will be disillusioned over its failure to find a place for them.

As for the problem of our capable aircraft factories, I hope that if we have learned anything from this war it is the fundamental lesson that our future national security demands that we keep this industry going at all costs. We must never again be caught unprepared, either in manpower or materiel.

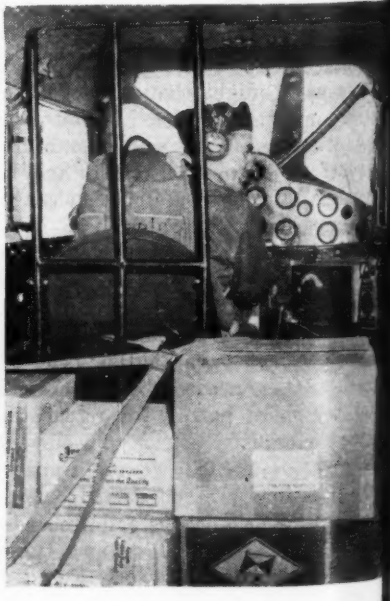
To keep the machinery and skills of these factories intact will require a sharing of the burden, by military, commercial, and private aviation alike. Our present trunk airlines cannot alone purchase enough new equipment to maintain production indefinitely—but a vastly expanded industry could take a long step in that direction.

Of course we do not offer the establishment of feeder airlines as a solution for these two problems in their entirety. It is obvious that the number of feeder routes that can logically be established limits the size of this development and the amount of employment it can support. But certainly promotion of the feeder airline field will constitute a step—and a big one—whose influence on the problems over a period of years will be considerable.

Fortunately, feeder airlines are not so replete with unsolved operating problems that almost immediate widespread development is impracticable, for considerable progress had been made in

"Hot freight" goes aboard Southwest Airways-operated feeder line plane to beat ground delivery time by as much as two days even though distances covered may not be great. Plane is four-place Waco, adapted to wartime job by such changes as installation of large cargo door.

Interior view shows how Southwest Airways converted Waco to wartime cargo lugger to speed delivery of vitally needed shipments to Army bases.



How eleven feeder routes could give air cargo service to 2,500,000 people in 295 cities is illustrated by this map showing routes applied for by Southwest Airways Co., of which author is vice-president. Company has already piled up backlog of experience in some of this territory through operation of feeder service over unrevealed war routes.

finding solutions even before the war.

In addition, the wartime emergency has (1) brought into existence the nation's second feeder airline, operated by our company over a large West Coast area for the Army Air Forces, and (2) greatly expanded the pioneer feeder airline system operated by All American Aviation. This has afforded still more opportunity to obtain valuable operating data and experience.

Perhaps the most important problem which has tended to delay general adoption of feeder airlines is the difficulty of maintaining schedules which capitalize upon the airplane's chief asset, speed.

The pickup type of feeder operation has successfully solved this problem for mail and express, solved it so well that pickup schedules can be operated which are closer to the actual cruising speed of the plane than feasible on trunk lines.

A study of trunk airline schedules indicates that with the DC-3, which has a cruising speed of about 185 mph., the scheduled speed is only 130 mph., a 70 percent utilization of the airplane's speed. On the other hand, All American Aviation has demonstrated conclusively that pickup schedules can be set at 80 to 85 percent of the cruising speed. There are two reasons for this: Feeder planes fly at low altitudes where head winds are not so strong, and feeder routes are almost always so crooked there are no continuous head winds.

However, I think it is obvious to all of us interested in the development of feeder transport that it must carry passengers, as well as mail and express. An air service that does not render all three services is not fulfilling its complete function.

Passenger carrying means slowing down of schedules, particularly if frequent landings are required. It is safe to predict that this will prove no major problem at the outset, for landings undoubtedly will not be required at anything like all of the points to be served. Thus, a combination of pickup and landings will work satisfactorily, both from the standpoint of the operator and the passenger.

Tests have been run in which passengers were carried through pickups, and nothing was found in the maneuver that was in any way objectionable. Almost without exception, test passengers indicated a preference to "fly through" a pickup rather than to land.

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Design for Survival

By JOHN FOSTER, JR.,
Associate Editor, "Aviation"

Aircraft producers' biggest problems can only be solved by Congressional action—with the help of the industry itself. A working design is available, but a big question remains: Will aviation give that help?

A PATTERN for the near-future course of aircraft production has been drawn by the nation's No. 1 industry itself—but whether the industry will work as a group to translate that design into a working model remains to be seen. It remains to be seen because of the knowledge—disconcerting as it may be—that the necessary 100 percent backing hasn't yet come to fruition.

On one fundamental point, however, there is unanimous agreement. This is that the aircraft industry's most pressing problems can be solved only with the backing of Congressional action. The approach must be made through *legislation* which will establish the national policy, not through *orders* of government agencies.

Meanwhile, Congressional leaders who today are working on legislation which will help solve these problems look to the industry for guidance. They feel perfectly justified in expecting—even in demanding—a united front by the industry.

Complete Cooperation Needed

Such guidance can grow from the preliminary design that came out of the recent Colorado Springs meeting of the Aero Chamber's Economic Development Committee. Whether the finished plan bears even extensive changes, or whether it is presented through the chamber or some entirely new trade association, are minor considerations. The point is that cooperative action, such as that which has been shown repeatedly through the Aircraft War Production Councils, is essential.

Perhaps nothing calls for quicker and more concerted action by the nation's plane builders than the renegotiation act. It is conceded that the aircraft industry's survival depends upon a change in one of the act's fundamental concepts. The act must be changed, as the committee recommended, to "let taxation come first and renegotiation come second." As was so ably pointed out at hearings of the House Ways & Means Committee by Francis A. Callery, Consolidated Vultee vice-president, and Ralph S. Damon, American Airlines vice-president, contract renegotiation should be based on net profits (if any) *after* taxes.

Whether, as Callery urged, Congress designates net profits of 3 percent on sales as the floor below which renegotiators may not go, is one of those parts of the preliminary design which can, if necessary, be changed. The fact remains, however, that the entire industry can agree that renegotiation needs to be revamped to become effective after taxes, and on this point it can present the essential united front to Congress.

An interesting feature—action upon which might well prove the industry's desire and ability to work together—is the committee's recommendation to "remove present secrecy from renegotiation so that management can know the treatment given to competitors before signing up." Certainly the present administration, with its predilection for seeking out cartels and secret agreements, should go along with this idea.

Closely allied with renegotiation is the vast problem created by the dire need for adequate postwar reconversion reserves. But here, too, there is available a design from which to work, for the committee recommended Congressional authorization of such reserves equal to 15 percent of the total normal, surtax, and excess profits tax that would be payable in event the reserves were not allowed.

This figure of 15 percent seems a reasonable amount on which the industry could easily present a united front to Congress, particularly in view of the fact that British producers have coming to them a 20 percent postwar tax refund—a refund established partially for the avowed purpose of recapturing foreign markets.

While this fact serves as a reminder to Congress that the country needs, and needs now, a national aviation policy, it by the same token must serve as a reminder to the industry of its obligations—both to itself and the nation—to become active in writing that policy.

Just as important, and as much of a headache, is the problem arising from contract terminations. It, too, presents a job on which the industry may or may not, as it chooses, be of material assistance to Congress. For action such as the committee recommended be taken is needed to formulate "a broad declaration of national policy in connection with settlement of war contract termination claims which should be a guide to contracting officers in settling, and to federal courts and boards in rendering decisions on contract termination claims."

Basis for Plan Ready

But here, too, the design has been provided—in the committee's recommendation for "legislation providing for uniform termination procedure which will be applicable both to existing and future prime contracts and subcontracts which would assure the legality of regulation issued thereunder. Any legislation should, however, recognize the validity of commitments made in good faith prior to the effective date thereof."

Outstanding point of this part of the design, and one sure to get vocal attention from the industry's snipers, is the urging "mandatory advance payments up to 90 percent of the cancellation and termination claims without any interest charge."

Why 90 percent, when general industry asks for but 75?

For the simple reason that a decline of but 11.6 percent in inventory value alone could wipe out the industry's entire working capital. Come the end of the war, such a decline probably would represent even the first five minutes' inventory value drop.

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• The Economic Development Committee of the Aeronautical Chamber of Commerce came out of its recent Colorado Springs meeting with, among others, two important recommendations for action by the chamber's Board of Governors.

These recommendations can, says the author, form the preliminary design for a course of action by which the industry can help itself and Congress—action which will be necessary for final solution of vital problems facing the nation's biggest industry. Even though they may be changed, these resolutions on contract renegotiation and termination might well form the basis upon which the industry can show 100 percent cooperation on questions which affect its very existence.

Cancellation Demands Action—And Quick

By RAYMOND L. HOADLEY
Financial Editor, "Aviation"

Against a still-weird backdrop of 1918 contract-termination ghosts, today's governmental Macbeths are beginning to repeat World War I's tragic cancellation lines. Congress alone can write in the practical legislation needed to save this legal script. And it will take writing on the double to do it—for Act II is coming up fast.

IF WE WANT TO WIN the peace as well as the war, speed is just as essential in terminating war contracts as it was in letting them. Yet the contract cancellation situation is just as confused today as it was six months or a year ago.

Meanwhile, nearly $9,000,000,000 worth of war contracts have already been cancelled, compared with $7,500,000,000 at the end of World War I.

We are drifting into contract cancellations just as casually as we did in 1918. Now, as then, the various government procurement agencies lack a uniform termination policy. And now, as then, Congress delays on termination legislation, provides no relief for damages suffered under defective contracts.

If the war should end today more than $100,000,000,000 of claims would have to be investigated, negotiated, and (many of them) litigated. There is not sufficient manpower available to handle the 250,000 contractors and more than 1,000,000 subcontractors who would be standing in the termination breadline. Behind them would be millions of workers unable to get jobs in paralyzed industries.

More than 12,000 claims had not been liquidated nine years after the last war ended, as Sen. Murray of Montana recently pointed out, some claims from that war are *still* unsettled. The War Department had—by the end of August effected final settlement in 6,191 terminated cases out of 8,520 pending. But because the amounts involved in this war are so vastly larger, the consequences of delays are much more serious. It will be disastrous enough for the large companies to have their working capital tied up in contract termination knots. It will inevitably sound taps for the little fellow.

Experiences war contractors already have had with termination show what a lengthy red-taped affair it can be and often is. Westinghouse Electric & Mfg. Co., for instance, has had large amounts of working capital tied up in cancellations of contracts totaling over $141,000,000.

What would happen in like circumstances to the aircraft companies, none of which have the financial resources of this great electrical equipment concern?

Another example is International Harvester, which had a $200,000,000 tank contract cancelled last April just as tanks were beginning to roll off its assembly lines. Some 500 subcontractors and 1,500 other firms were involved in this huge contract. Harvester had to

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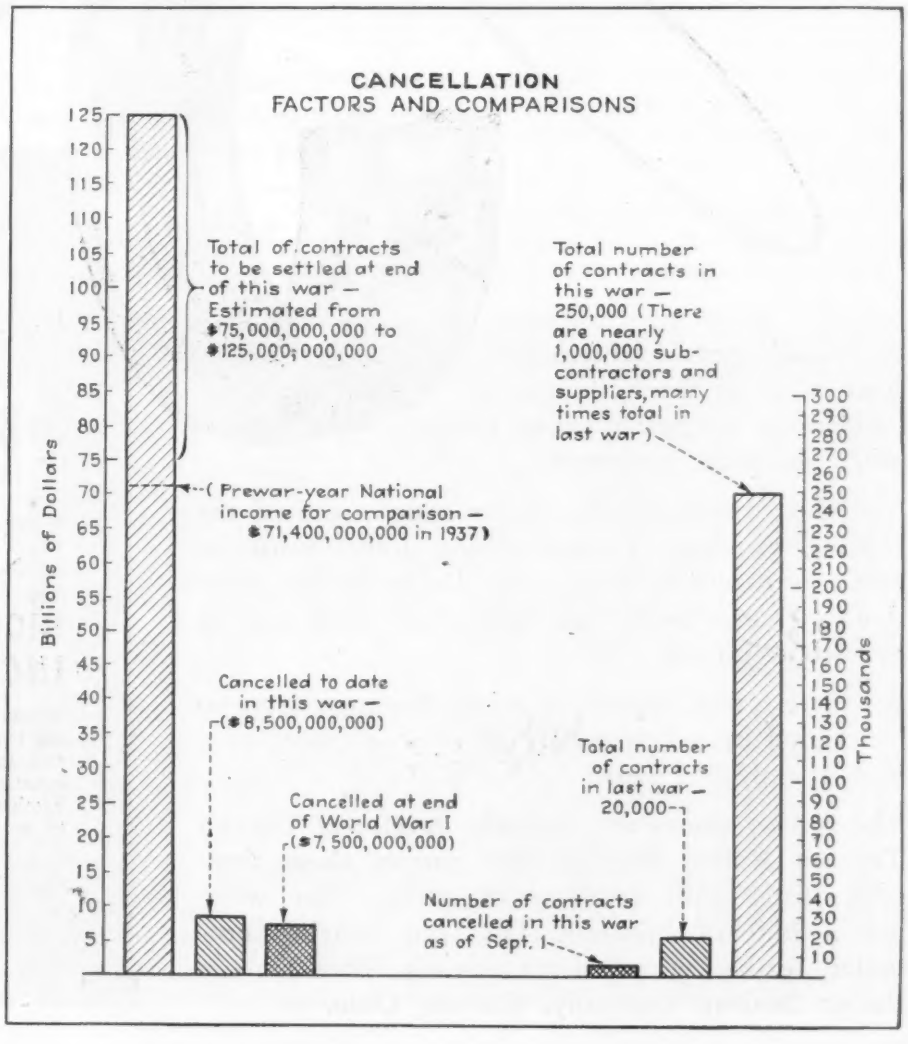
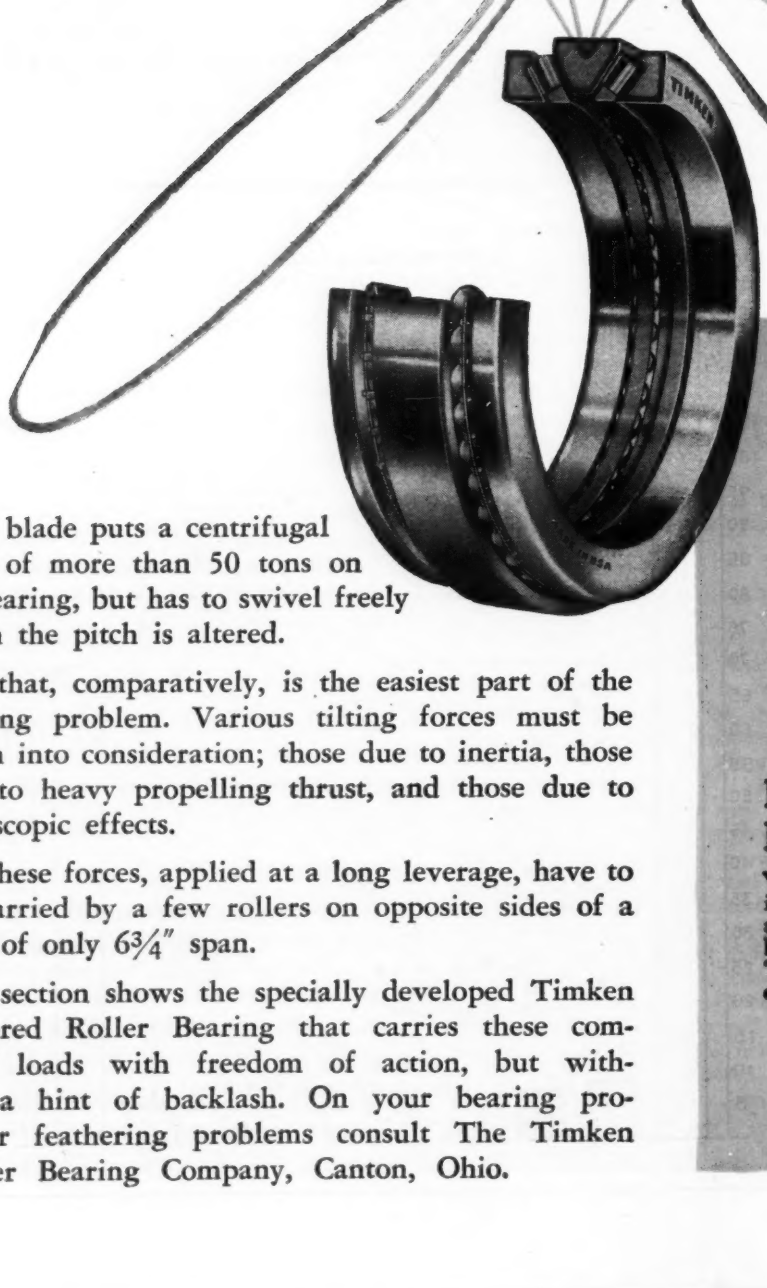

CANCELLATION
FACTORS AND COMPARISONS
Billions of Dollars
Thousands
Total of contracts to be settled at end of this war — Estimated from $75,000,000,000 to $125,000,000,000
Total number of contracts in this war — 250,000 (There are nearly 1,000,000 subcontractors and suppliers, many times total in last war)
(Prewar-year National income for comparison — $71,400,000,000 in 1937)
Cancelled to date in this war — ($8,500,000,000)
Cancelled at end of World War I ($7,500,000,000)
Total number of contracts in last war — 20,000
Number of contracts cancelled in this war as of Sept. 1

Over 50 Tons
the weight of two flying "FORTS"
ON EACH BLADE BEARING



Each blade puts a centrifugal load of more than 50 tons on its bearing, but has to swivel freely when the pitch is altered.

Yet that, comparatively, is the easiest part of the bearing problem. Various tilting forces must be taken into consideration; those due to inertia, those due to heavy propelling thrust, and those due to gyroscopic effects.

All these forces, applied at a long leverage, have to be carried by a few rollers on opposite sides of a base of only 6¾" span.

The section shows the specially developed Timken Tapered Roller Bearing that carries these complex loads with freedom of action, but without a hint of backlash. On your bearing propeller feathering problems consult The Timken Roller Bearing Company, Canton, Ohio.

HIGHER LOAD CAPACITY
INCREASED STABILITY

Wherever the Timken Tapered Roller Bearing is used it results in higher load capacity and increased stability against every combination of stress. This illustration shows Timken Bearings as mounted in the hub of a controllable pitch propeller blade.

TIMKEN
TRADE MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Associate Producers Plan Speeds CG-4A Gliders

By OTTO W. TIMM

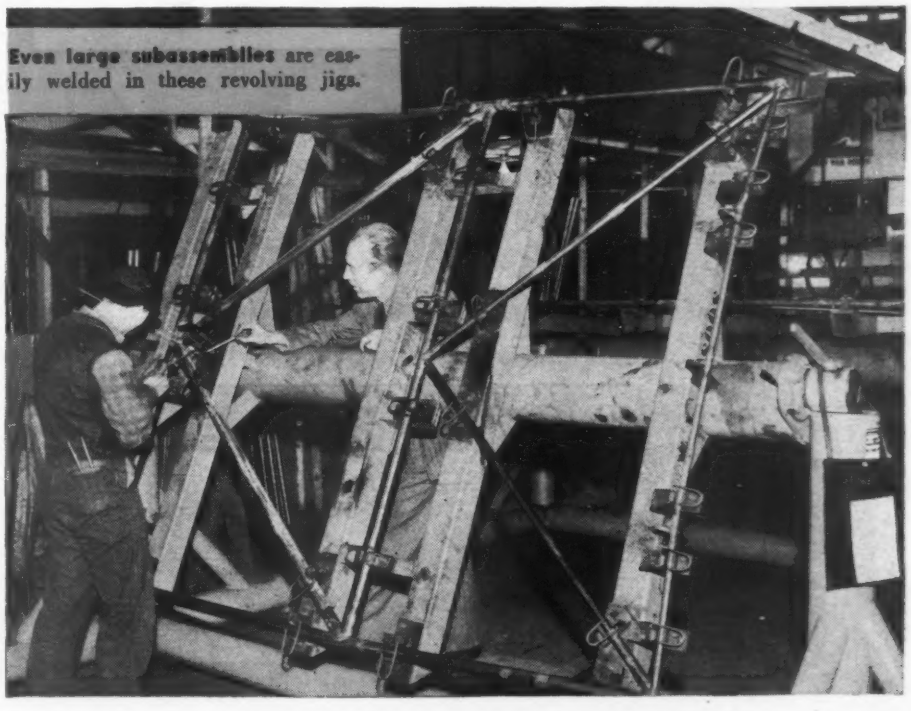
President & Chief Engineer, Timm Aircraft Corp.

How eleven California manufacturers pooled their peace time equipment "the associate way" and are doing an outstanding job producing troop gliders. . . . Told by the man who effected the practical plan.

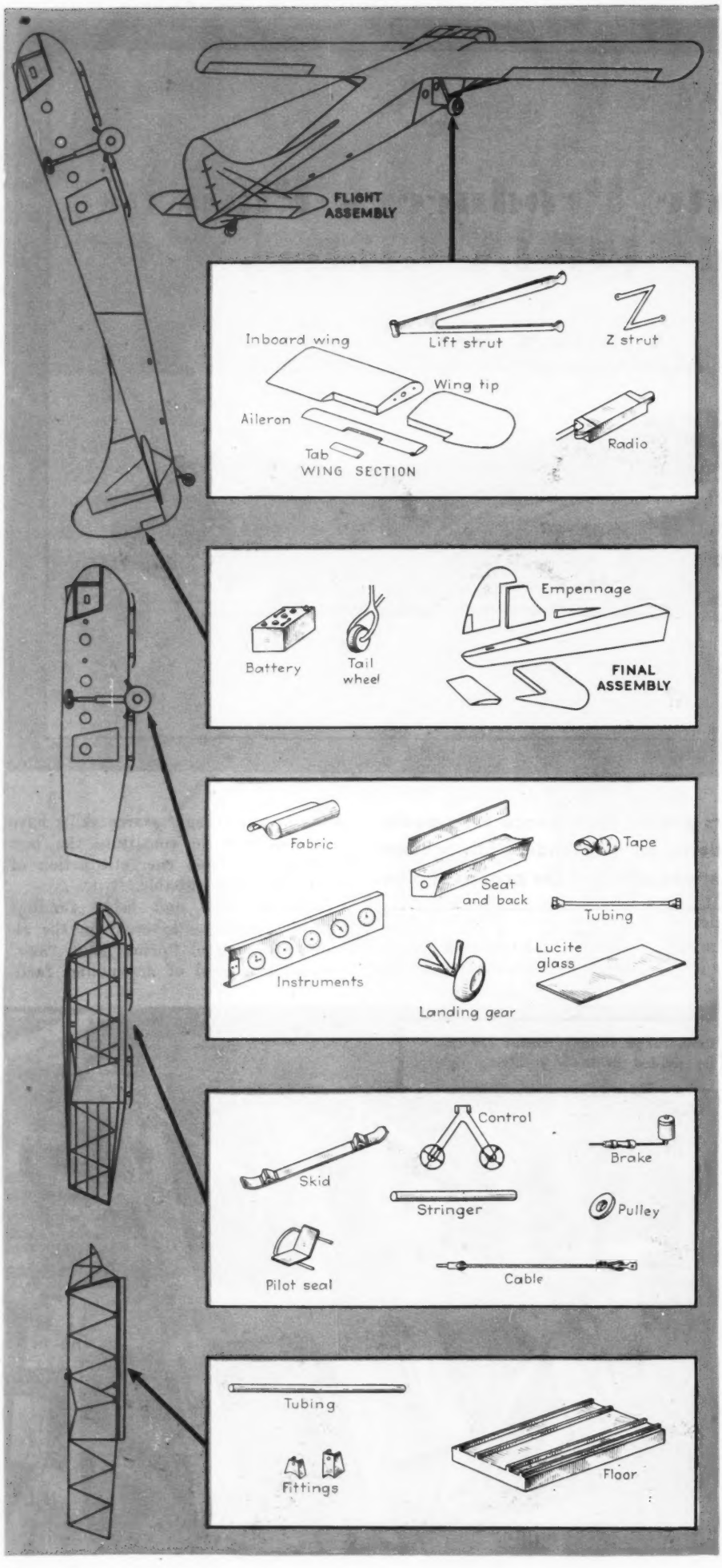
OUR American aviation industry's contribution to the winning of the war, and the peace to follow, will undoubtedly constitute an enormous portion of the total Allied effort. It will, it seems certain, afford all divisions of the industry an ample portion of the satisfaction everyone of us gets in playing an important, even if small, part in the making of history. But, we also like to feel that in doing our part we conceived and executed something that adds to the sum total of our industry's accumulation of vital experience and knowledge.

Such a contribution, we believe, is our Timm Aircraft & Associate Producers system of building the CG-4A troop transport glider. Designed by engineers of the Army Air Forces and the Waco Aircraft Co. and built by several other aircraft and glider concerns, the product is a standardized one in which nothing in design or choice of material can be original. Very little that is original can be contributed by individual contractors to the basic methods of its construction. However, accomplishment of the desired results quickly, utilization of existing plants and machines, and more efficient application of exceedingly scarce skills have been combined to constitute the best thinking and most energetic action of which we were capable.

Realizing this, and being familiar with the problems inherent in the already widely used "prime" and "sub" contractor method of assembling facil-



Even large subassemblies are easily welded in these revolving jigs.



Order of flow of prefabricated components in assembly at Timm plant.

ities and "know-how," our search turned toward finding still another system which might prove even better. With our judgment now confirmed daily for the past several months, we feel that a contribution may be made to the industry's war effort by reporting our experience with this program, which we call the Associate Producers Plan.

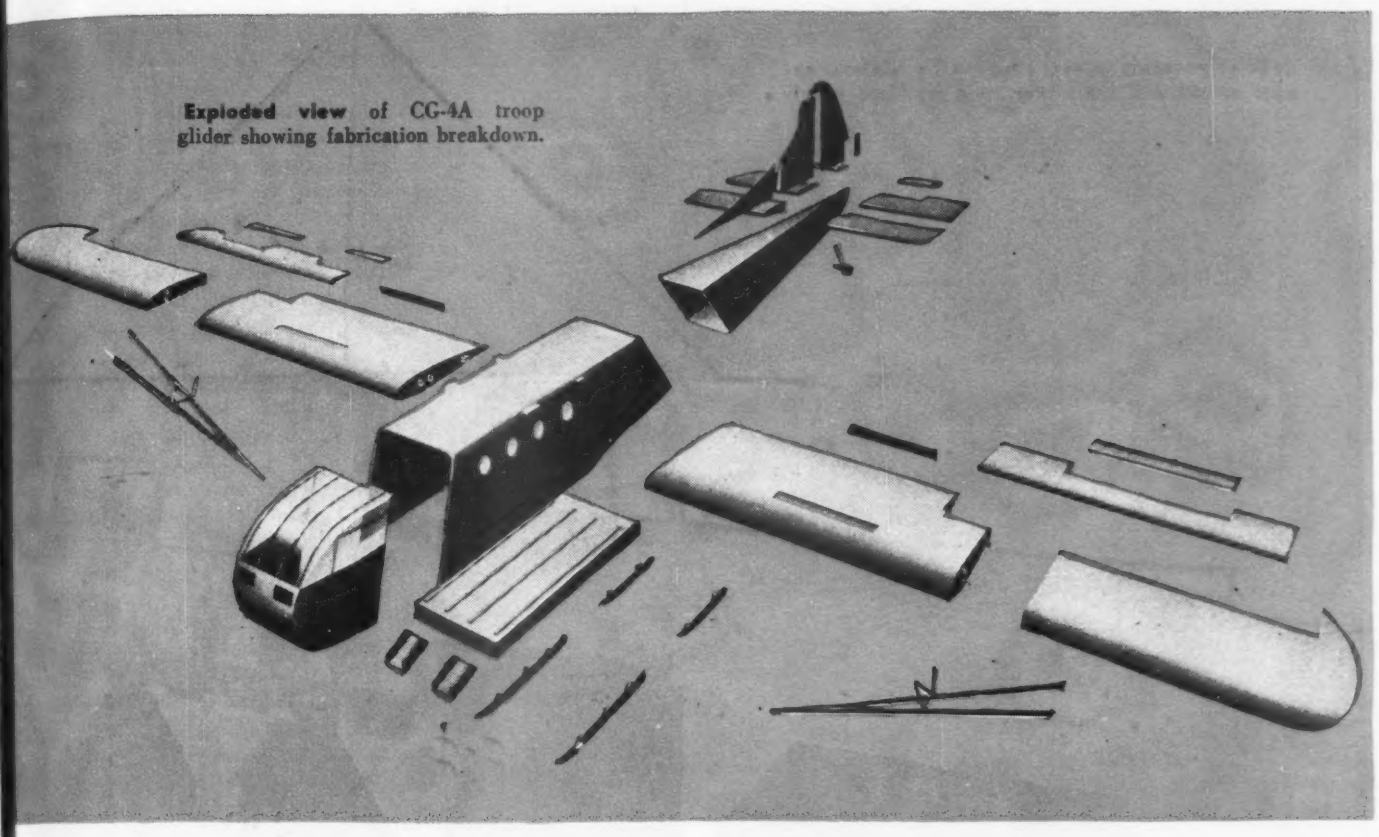
With our belief in gliders as military weapons confirmed by the Nazis' successful use of them, we launched a search for a plan to make them quickly. We figured the system we needed should not require erection of large, new plant buildings and the purchase of extensive and hard-to-get equipment. Yet it should quickly produce the quality and volume our AAF would undoubtedly require.

Weeks and weeks were spent searching the Los Angeles area, where the Timm peacetime aircraft plants are located, for established concerns with the plants, equipment, and knowledge for manufacturing the various components of a big glider. The result has been a pooling of manufacturing facilities that pours in the components from virtually all geographical directions—to a centrally located final assembly line. This entails no excessive transport requirements and demands not one cubic foot of new plant construction, yet it gives volume production that is easily meeting continually increasing contract requirements.

This preliminary work was done shortly after the German glider invasion of Crete—long before our U. S. glider program got under way. When the AAF asked members of the aviation industry to undertake portions of its glider program, our associate producers plan was the major factor in obtaining for our group the only transport glider contract awarded on the Pacific Coast.

Instead of the usual prime-and-sub-contractor arrangement of transporting components to an already established assembly plant (sometimes not conveniently located) Timm Aircraft Corp. leased an existing, although not perfectly suited, warehouse building because it was the hub around which the other plants were ranged. With a minimum of building alterations, we set up our fuselage final assembly line in this structure.

To this line flow components fabricated by ten of our eleven associate producer companies, several of them larger than our own organization and most of them longer established. Each fabricates one or more components or parts. These producers were selected on the basis of their peacetime experience in working with the materials, with con-



Exploded view of CG-4A troop glider showing fabrication breakdown.

sideration of the skills and equipment they could bring to bear.

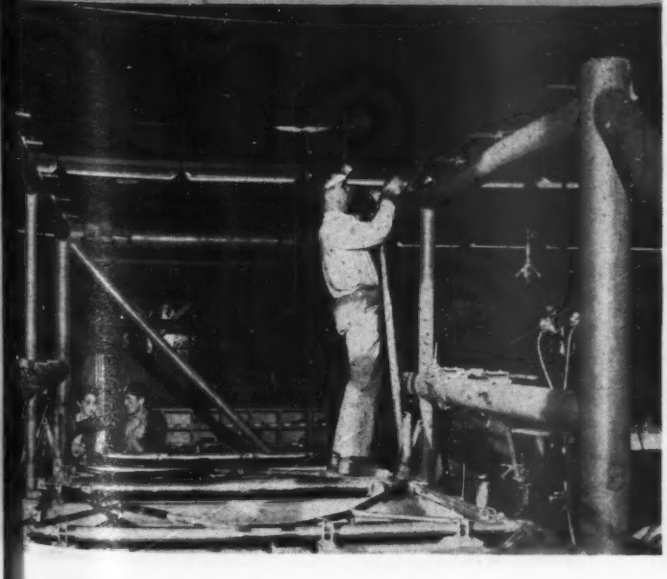
Being familiar with the glider in all of its phases, the Timm organization supplies all materials, general supervision of fabrication and, in some instances, the timekeeping and bookkeeping. Timm liaison men (some call them expediters) are on duty in all of the plants to help solve problems and to keep production rolling smoothly. Other than that each associate is on his own, doing his job or jobs by means developed by his own staff. Our own inspection and that of the AAF is, of course, done in each plant.

In all instances where it has been deemed necessary, we have set up a primary and a secondary (or emergency) source of each component. If a stoppage, for any reason, should shut off production in a primary source plant, schedules can still be maintained, at least for quite some time, through production of the component by its secondary source.

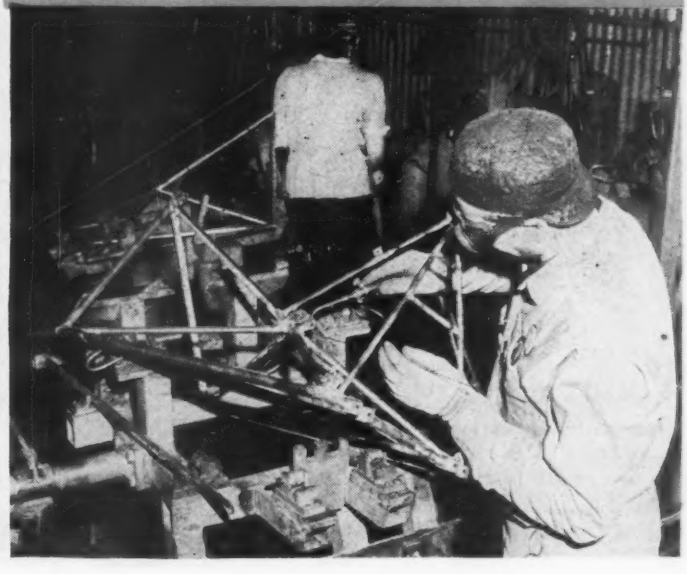
Without attempting to classify the associates in an "order of importance" sequence (because all are ranked equal and all work done is vital) let me list them and briefly outline the backgrounds which prompted their selection for these jobs.

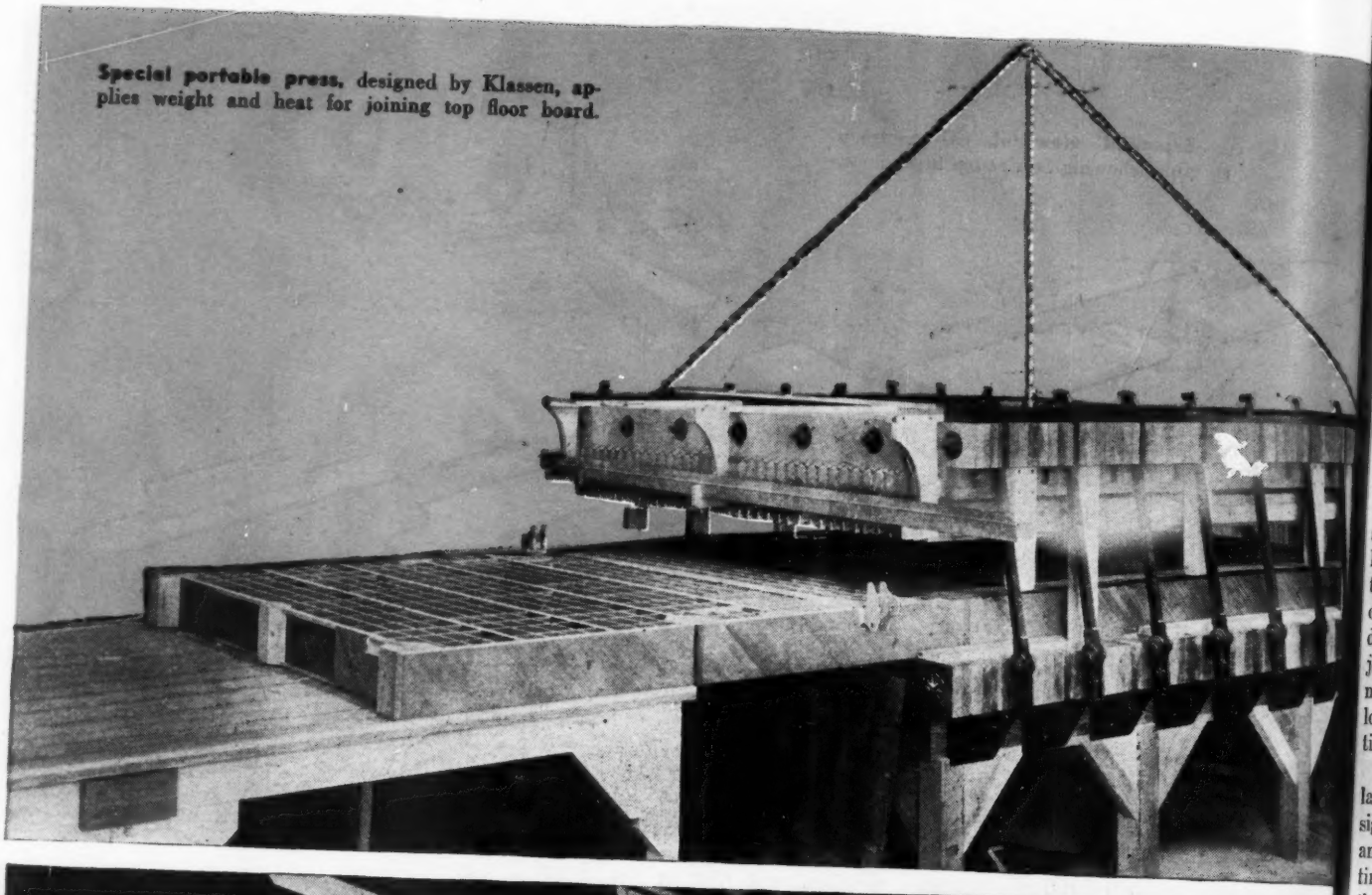
Inner and outer wing sections and several smaller parts are the responsibility of the Weber Show Case & Fixture Co., which in prewar times was the largest concern in those fields in the Southern California area. The company's 40 yrs. of experience covers all manner of fabrication with hard and soft woods, plywoods, plastics, and

Simple construction and quick-acting clamps reduce assembly time in this jig.



Jigs are welded by Harlow Aircraft Co., using gas piped from a central source.





Special portable press, designed by Klassen, applies weight and heat for joining top floor board.

In this final assembly jig for aft frame section holes are drilled with counterbalanced electrically-powered tool which swings to all parts of work. Harlow was designer.

several kinds of metals as daily work.

Empennage assemblies and floor boards are fabricated by the Angelus Furniture Mfg. Co., one of the West's largest manufacturers of household furniture. The Los Angeles Period Furniture Co. makes wing ribs and fuselage fairings. The Kassen Co. makes floor boards. Harlow Aircraft Co., peacetime manufacturer of small planes, turns out fuselage frames and fittings.

The Metal Products Engineering Co. produces control columns, and the Essick Machinery Co. works on fuselage frames and fittings. Jigs are being made for the other associates by Crown Craft Corp., specialists in such work.

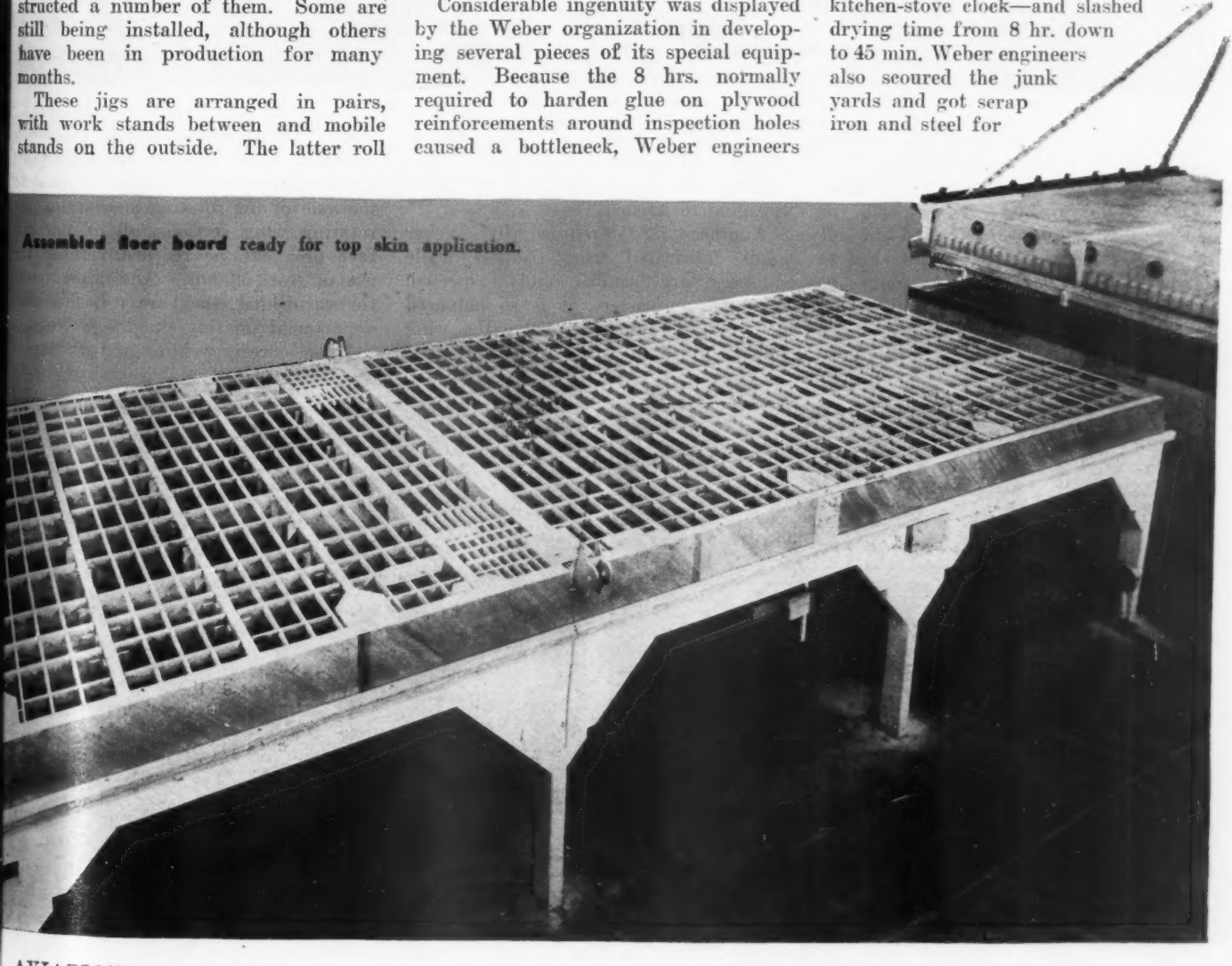
Being an associate, rather than a subcontractor, each of these concerns has an assured, continuing place in the program. For that reason each is continually improving its techniques and developing new equipment for doing the job better and faster. Because it does not have to hedge against a possible loss of contract, it willingly and continuously invests in improved facilities.

At the Weber plant, for example, large two-level vertical jigs were designed and built for constructing inner and outer wing sections. After continued use confirmed the efficiency of the design, the tooling department constructed a number of them. Some are still being installed, although others have been in production for many months.

These jigs are arranged in pairs, with work stands between and mobile stands on the outside. The latter roll out of the way when work is to be done below the floor level of the stand, or when completed sections are to be lifted from the jigs.

Considerable ingenuity was displayed by the Weber organization in developing several pieces of its special equipment. Because the 8 hrs. normally required to harden glue on plywood reinforcements around inspection holes caused a bottleneck, Weber engineers recovered a discarded jigsaw frame from a junk pile, equipped it with an air cylinder and two electrically heated plates, did the timing with an ordinary kitchen-stove clock—and slashed drying time from 8 hr. down to 45 min. Weber engineers also scoured the junk yards and got scrap iron and steel for

First floor board, completed and ready for assembly.



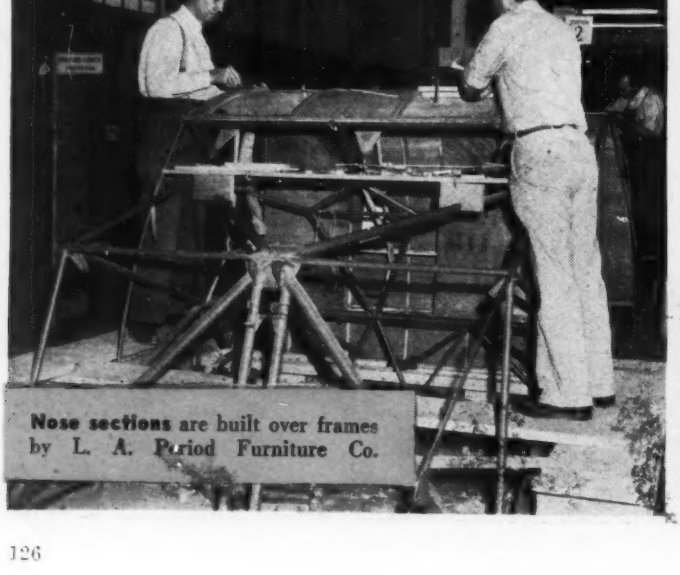
Assembled floor board ready for top skin application.

Using these jigs, wing ribs are readily assembled by workers with little previous training.

construction of a spar cap profiler that in three cuts completely profiles the four-dimensional thickness of this part. Also standard quick-acting cam or "C" clamps, commonly used in all wood working shops, were attached to the bottom of a spar jig by hinges so that they swing downward and out of the way while loading or unloading the jig. They quickly can be swung into place and tightened, at the proper places, when needed to clamp a spar together for the several hours required for glue to harden.

Another jig developed by Weber holds fabricated wing sections while surfaces are sanded and inspected. Mounted on casters, it is so balanced that one worker can revolve the wing section (on a longitudinal axis) to any desired position and lock it by merely inserting a pin through holes provided for that purpose in a disk attached to the axle of the rotating mechanism. By rotating wing sections, all of the surface area can be reached without the use of work stands. And when ready for varnishing, they are rolled to that department on this stand.

Experience in welding of tubing, plus



Nose sections are built over frames by L. A. Period Furniture Co.

Closely fitted tail frames are also made by this furniture company.

the assured stability its associate producer status provided, spurred the Harlow Aircraft Co. to design jigs and welding equipment that has put fabrication of the fuselage frames on a smooth-flowing mass-production basis.

All jigs in the Harlow plant were designed by that company's engineers, and they are of the rotating type wherein assemblies can be revolved 360 deg. and instantly locked in any position desired by the welder. Welding gas is piped from a central source, under proper pressure, to each working station. Drop pipes equipped with valves and gages bring the gas to a point nearest to the working position. Hence, hoses to torches need not be long and therefore likely to get in the way of the welder.

As in all mass production, the Harlow system begins with small subassemblies that progress through a procession of jigs until a completed fore or aft fuselage section frame results. These are then prepared for joining in a rather novel jig which not only permits additional welding together of a section but also accurate spot facing and drilling of bolt holes in attachment fittings. Fore and aft frames are not actually joined until all assembly and installation is done in our Timm plant.

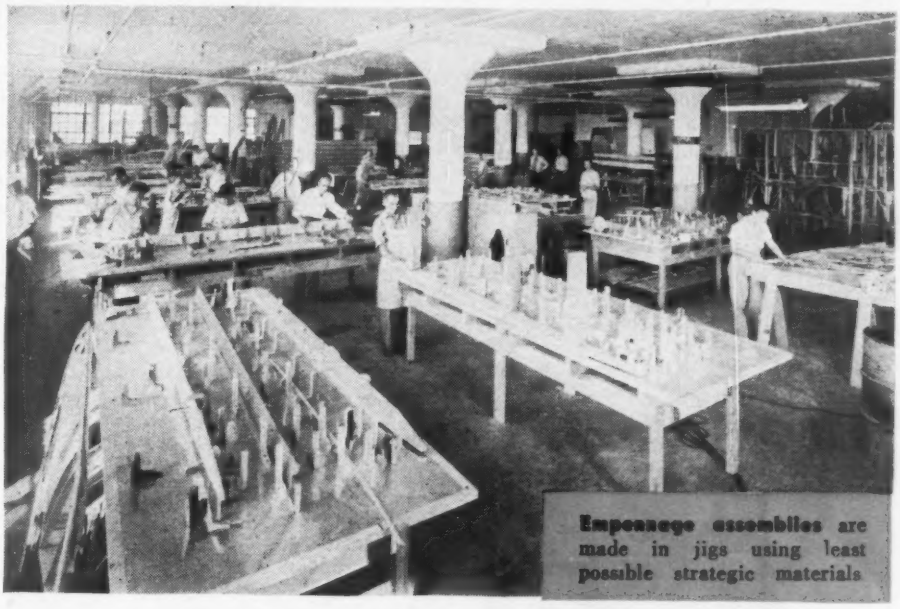
For a large-volume source of wing ribs affording direction by men experienced in the rather delicate type of fabrication required for these wooden pieces, we secured the Los Angeles Period Furniture Co.—a concern which has had many years of experience in solving the manufacturing problems inherent in producing a large variety of such furniture pieces. Selection of this company has resulted in a system of assembling ribs (from pre-formed cap strips, nose blocks, verticals, and gussets in jigs) that takes most of the skill requirements out of the job, hence it can be done by women and girls with very little training.

Nose fairings, another part produced by this firm, are fabricated over an actual nose section frame, used as a jig, from which they are removed when completed. Tail cone assemblies are still another rather delicate type of structure produced by this plant.

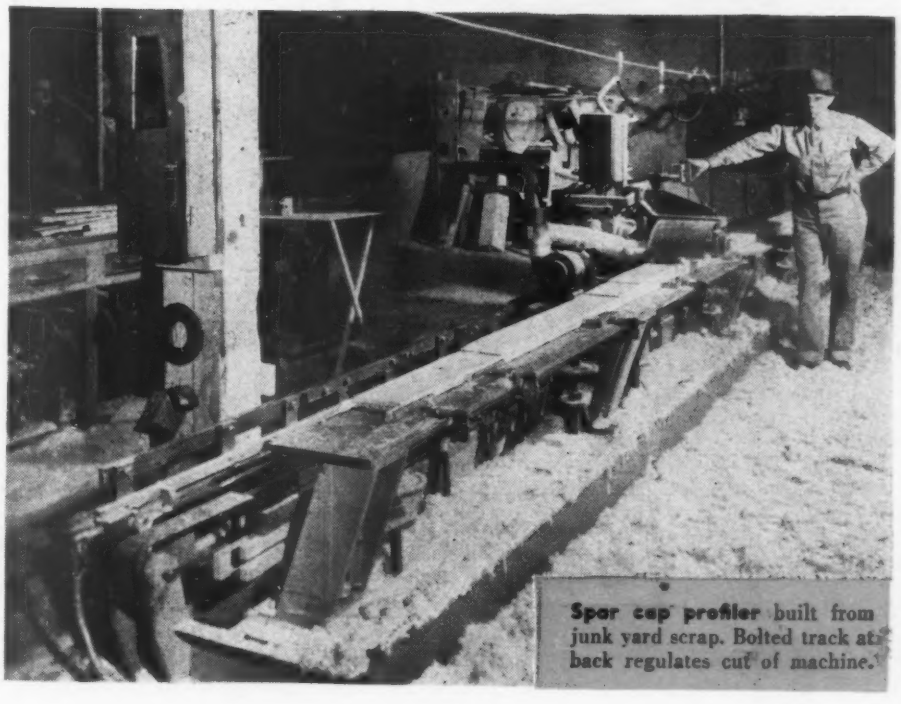
The Timm portion of this system—final assembly—is carried out under somewhat greater difficulties than are encountered by our associates. This is because of our decision to locate the final assembly line as near as possible to the geographic center of the associates' plants. However, the plan reduces transportation needs, and it has worked out very well, despite the fact that the only available building was not perfectly suited to our needs.

While adequate floor space was available, it was badly cut up by pillars and

Curved work for empennage assemblies is routine for Angelus Furniture Mfg. Co.

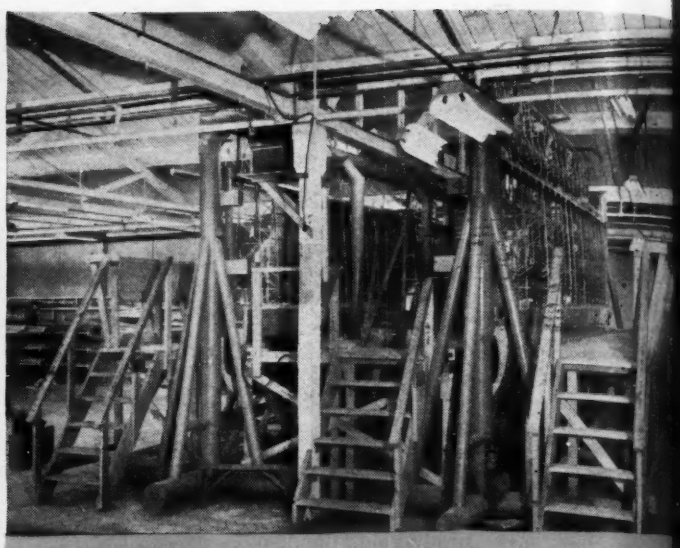


Empennage assemblies are made in jigs using least possible strategic materials



Spar cap profiler built from junk yard scrap. Bolted track at back regulates cut of machine.

Ordinary adjustable clamps are hinged to underside of spar jig, insuring speed and accurate spacing.



Inner wing panel jigs by Weber permit work on both sides of wing. Leading edges are prefabricated and placed in jig.

partitions that could not be removed. This necessitated jogs in our assembly line. But in spite of these, our production staff has adapted this building so well that we have readily held up our end. And in addition to assembly, we have established a welding department for fabrication, in a secondary capacity, of frame structures.

Prefabricated frames are placed on castered dollies upon arrival and are then stored adjacent to the head of the assembly line. After inspection they move to the line and begin the trip through 32 stations of this plant prior to being transported, virtually complete, to our "Station 33," located in a hangar building at the airport. There the wing sections, delivered direct from the Weber plant, are joined; and after final inspection, the completed glider is test flown and "sold" to the Army Air Forces. In some instances we crate and ship the gliders rather than fly them away.

Two electric heater plates, a junked jigsaw frame, a kitchen-stove timer, and a home made cylinder form this reinforcement drying machine. It cuts gluing time from 8 hr. to 45 min.

The handling of the fore and aft fuselage sections on our assembly line was a fairly simple matter up to the point where they reached the joining stage where empennage sections had to be added. Here, ceiling clearances posed a tough problem. However, our engineers solved the puzzle. The building, as mentioned before, had been a warehouse and had a row of big, arched loading doorways along one wall. Outside of these we built a temporary addition high enough and of sufficient width to permit all phases of empennage addition work. Then our stations were so arranged that aft fuselage sections, already joined to the force section, extend through these arched doorways while empennage work is in progress. These assemblies are then removed while the now-completed fuselages are being transported by trucks to "Station 33" at the airport.

One floor of our Timm plant is devoted to storage of reserve stocks of completed components. By bringing them to the assembly building they serve as a reservoir which keeps the "pressure" on our line constant and at the same time eliminates the need for large storage space in associate plants. This feature is particularly appreciated by the associates because all of them are engaged in other war production work,

Angeles Ladder Co. turns out skids by the processes ar to those formerly used for peacetime products.

This sander had a long peacetime history before it was put to work on glider parts by L. A. Ladder Co.

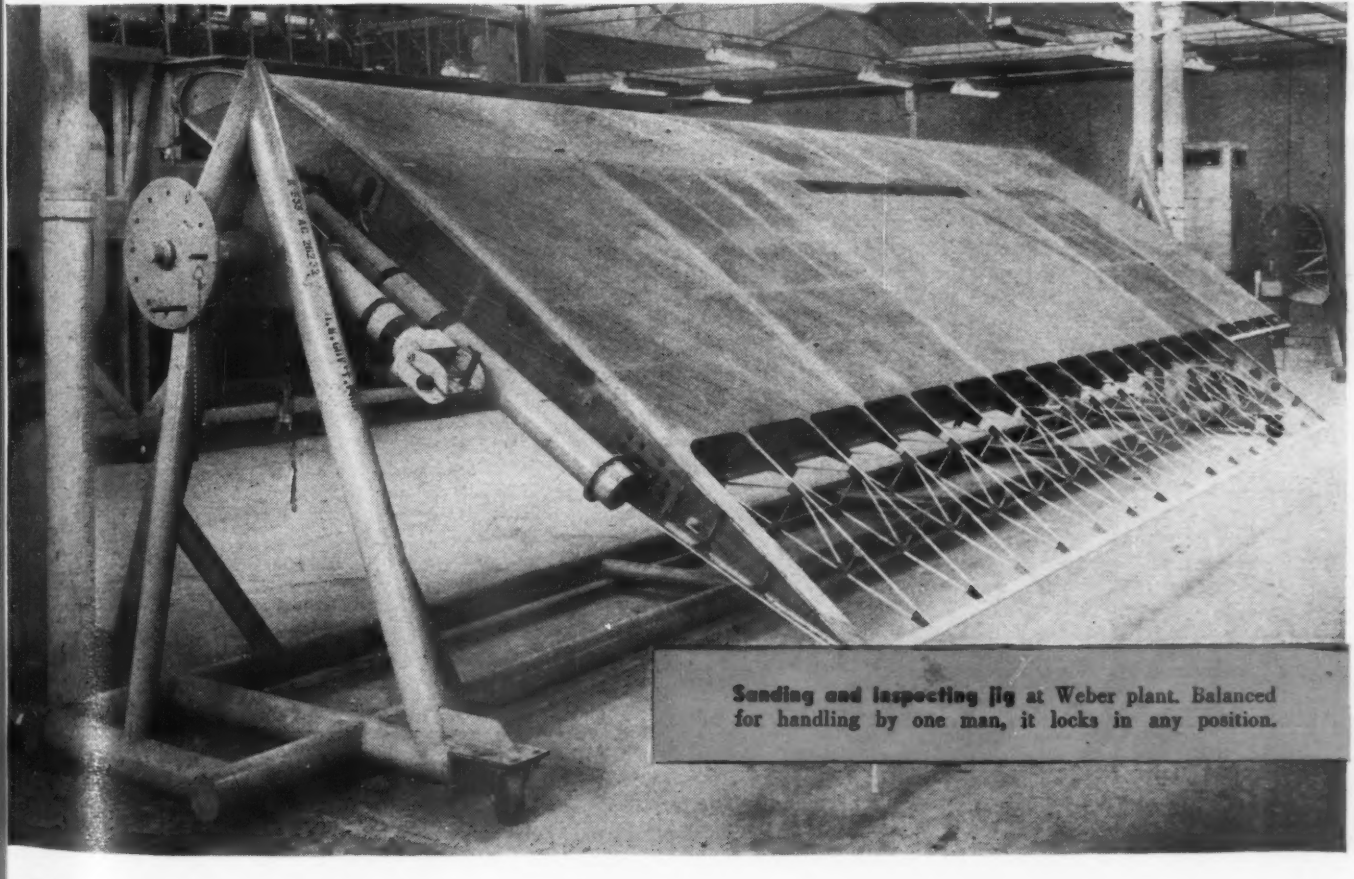
hence they need full floor space for fabrication and the usual raw material storage.

As we see it, after what we believe is a fair test, the associate producer system has many advantages to recommend it. We would say the principal one is the stability it creates among all participants. Each concern in this group, being more than merely a subcontractor, naturally shares to a greater extent in the responsibilities of the whole project. The place of each is not subject to change as might be the case with a differing set-up. And being associates, we all draw upon one another for help if and when it is necessary.

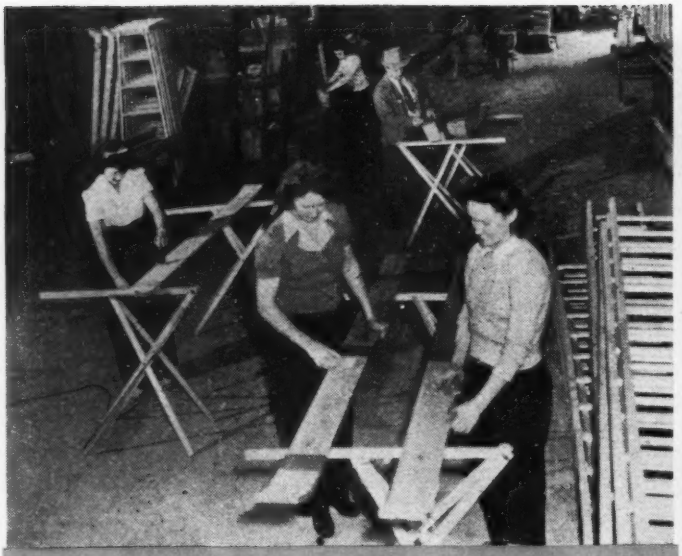
We believe that because each associate is an established, successful concern in its own right, with skilled management on the job in its own plant at all times, this system eliminates lags and many mistakes.

Under the associate producer system, full and final authority is always on tap in each of the component plants. Instead of going out and locating, altering, and equipping several more or less temporary plants grouped around the main, central factory, we established one more or less temporary central plant and kept our fabricators in their own buildings.

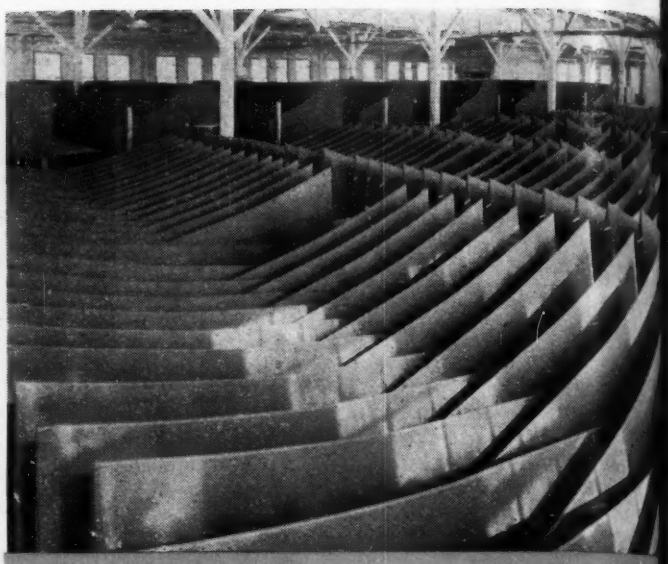
There is in this system still another advantage which we cannot, of course, prove by citation but which it has been our observation exists nevertheless. That is friendly rivalry. Every plant in this group has done and is continually doing



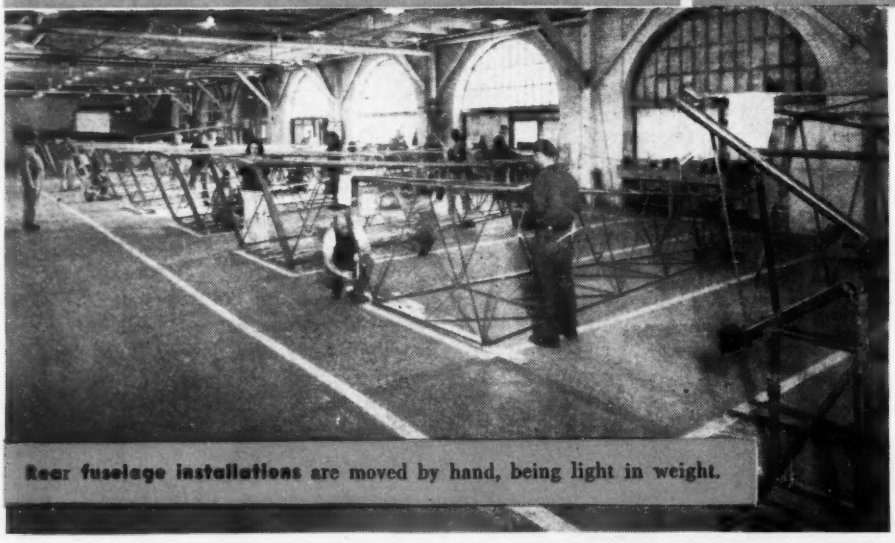
Sanding and inspecting jig at Weber plant. Balanced for handling by one man, it locks in any position.



Ladders of yesterday are piled alongside as workers of today turn out glider skids.



Entire floor of assembly warehouse is used to store finished components. By keeping them at central plant, "pressure" is maintained on final assembly lines, and space is saved at associate plants.

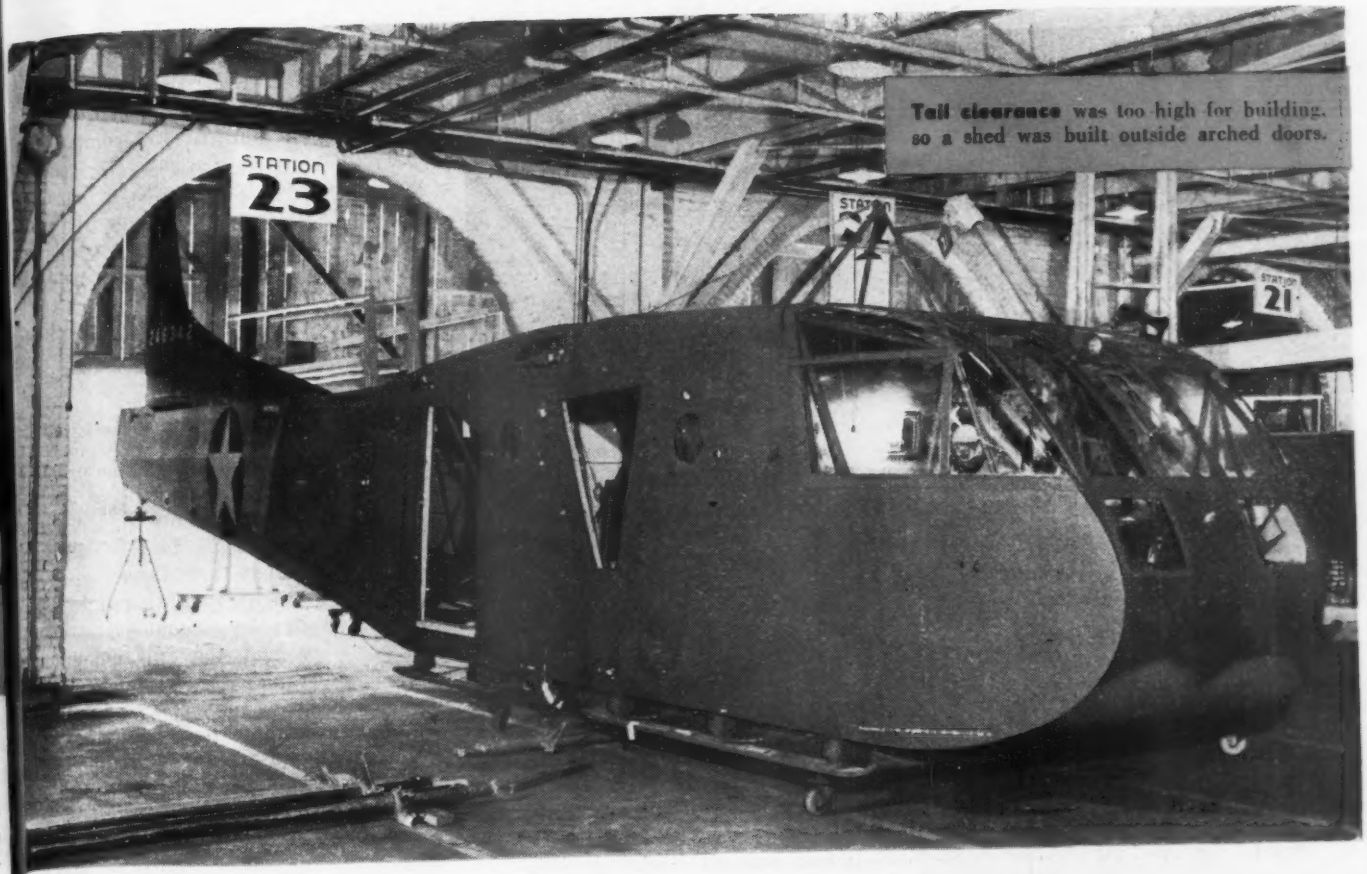


Rear fuselage installations are moved by hand, being light in weight.

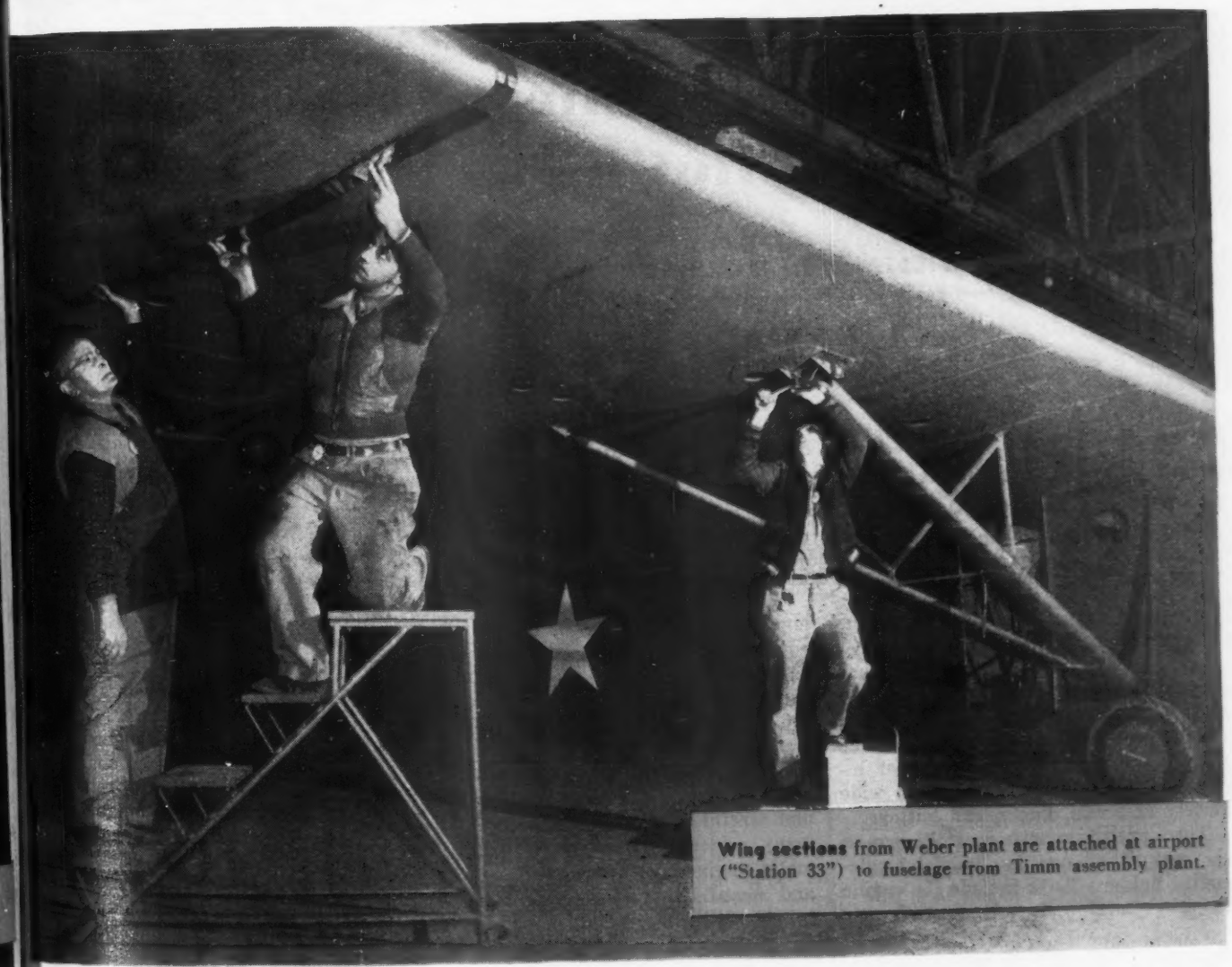
all in its power to smooth out and speed up its own portion of the project. We all feel we are "in" on something direct and important in the war effort, also that our experience as associate producers may contribute something new that will be of value both during and after the war. Moreover, we are enjoying working together because we so thoroughly understand the over-all picture of what we are doing.

Our associate producer does not feel he is merely fulfilling a contract that may not be renewed next month. Indeed, he will tell you that he is doing more than making parts, emphasizing that he is contributing a share in one big job, according to his own experience.

This old warehouse, being centrally located, is used as Timm assembly plant. Portable banks of lights are used.



Tail clearance was too high for building, so a shed was built outside arched doors.



Wing sections from Weber plant are attached at airport ("Station 33") to fuselage from Timm assembly plant.

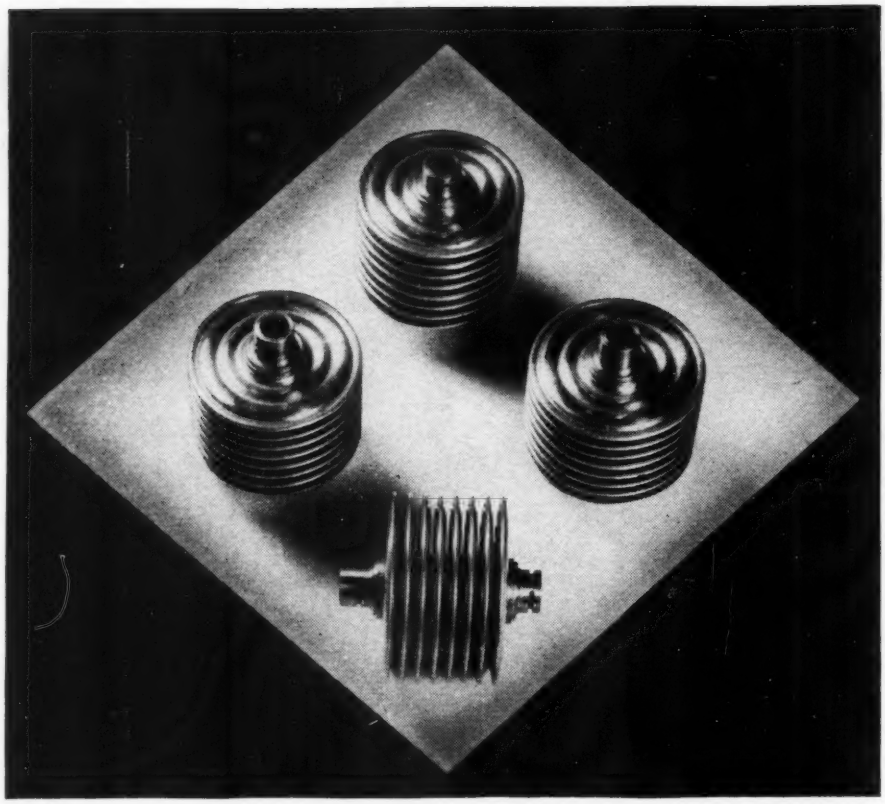


Fig. 1. Evacuated capsule used in Simmonds-Hobson automatic engine controls.

Engine Control Achieves Simpler Piloting

By WILLIAM J. MORRISON
Chief Field Engineer, Simmonds Aerocessories, Inc., and

A. P. FRAAS
*Author, "Aircraft Power Plants"**

Moves to ease the modern flyer's multiple job of dial-watching are primary, hence the marked significance of the Simmonds automatic power plant control. Described are the development and operation of this integral device which frees the pilot for other duties.

IT SEEMS GENERALLY AGREED that the pilot of a modern airplane powered with a highly supercharged engine has too many things to look after. Not only must he operate the control stick and rudder pedals to fly the airplane, but he must watch an impressive array of instruments, and manipulate a wide variety of levers, knobs, and buttons.

There are 13 separate control levers in the cockpit of one late model single-engine fighter. These include the engine throttle, mixture, and supercharger clutch controls, the propeller governor control, levers operating the cowl flaps, carburetor air heater valve, oil cooler shutters, the fuel tank selector valve, the wing flaps, and the landing gear retracting mechanism.

Of all these, the engine controls require by far the most frequent attention and careful adjustment. In spite of the many evident advantages of an automatic engine control, American pilots and manufacturers have been reluctant to add yet another complicated device to the airplane. However, the widespread and successful use of automatic engine controls in both British and German military airplanes in the past few years, together with the growing complexities of airplane operation, have changed this picture to the extent that Simmonds Aerocessories has been in quantity production of automatic engine controls for more than a year. The company is working under a license agreement with Hobson & Components, Ltd., of England, a firm which is a leader in this field.

Engine Operating Characteristics

First step in approaching the problem of automatic power control is a consideration of the factors limiting the power which an engine may be called on to deliver. There are three types of limitations. Light weight engines may be limited by the mechanical strength of parts so that the full amount of power which might be obtained must be restricted. A second type of limitation is imposed by the capacity of the engine to develop power—for example, it is often impossible at high altitudes to provide the engine with enough fuel-air mixture. The third type of limitation results from the power absorption and efficiency of the propeller.

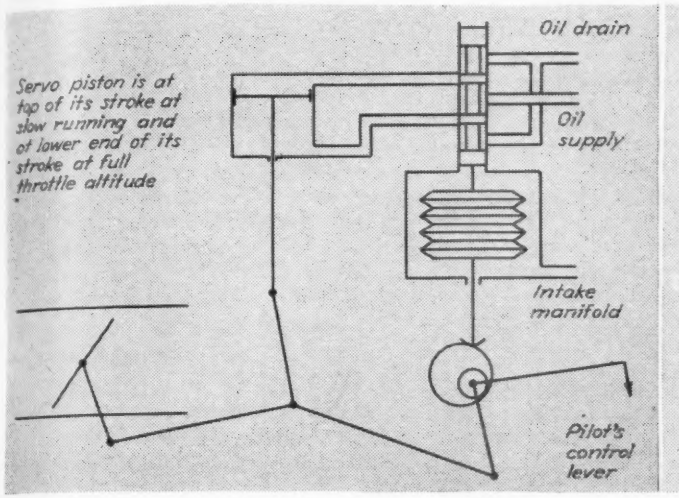
Maximum speed and rate of climb of an airplane can be obtained only if the engine is operated at the maximum permissible power output. This means that the throttle must be opened continuously to maintain a constant manifold pressure in a climb from sea-level to the altitude at which the throttle is wide open, i.e., the critical altitude of the engine. Similarly, in a descent, the throttle must be continually moved toward the closed position to avoid excessive manifold pressures.

In practice, of course, the pilot makes intermittent adjustments so that in a climb he ordinarily obtains less than the rated power output, and in a descent he is likely to endanger the engine if he neglects to throttle to a safe manifold pressure. Adjustments should not be made roughly; proper control requires a skilled hand and the close attention of the pilot during the adjustment.

Function of Auto-Controls

There are degrees of automatic engine control. All larger engines are fitted with propeller governors to maintain a constant propeller rpm.—to guard against the prime danger of overspeeding the engine with changes in flight altitude and also to relieve the pilot of a great deal of control adjustment which would otherwise be necessary. Since the rpm. is satisfactorily held constant by the propeller governor, the power output can be maintained at a constant value by an auto-control designed to maintain a constant man

* McGraw-Hill Book Co.


Oil drain
Servo piston is at top of its stroke at slow running and at lower end of its stroke at full throttle altitude
Oil supply
Intake manifold
Pilot's control lever

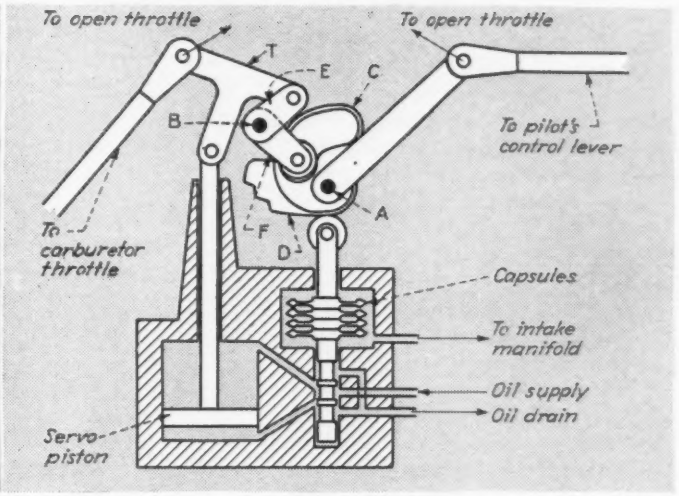


Fig. 2a. Schematic diagram of earlier type automatic engine control for boost only. **Right: Fig. 2b.** Schematic diagram of current Simmonds-Hobson automatic engine control showing throttle control mechanism. Shafts shown in solid black do not turn.

fold pressure, except for the negligible variations due to altitude-pressure changes.

An additional requirement is that it is essential that any auto-control be connected between the pilot's throttle lever and the engine, in such a way that the pilot can obtain simple mechanical control even if the automatic portion of the mechanism should be damaged.

Auto-Control of Manifold Pressure

Although different models of the company's automatic controls vary considerably in complexity and construction, some basic features are common to all types. The controlling element in each unit is an evacuated capsule, such as that shown in Fig. 1. These are made of a stack of diaphragms soldered together, evacuated, and sealed. An outstanding characteristic is their fatigue strength, for of the many thousands which have been in service with the RAF for the past seven years, not one instance of failure has come to our attention. In all units, the capsule operates a valve which supplies oil to a servo piston. The servo piston operates a member of the throttle linkage.

Earliest type in this series of automatic engine control provides such control only for manifold pressure or boost. Schematically shown in Fig. 2a, this unit is arranged so that a cam is linked to the pilot's throttle control lever. As the latter is closed, the cam rotates to

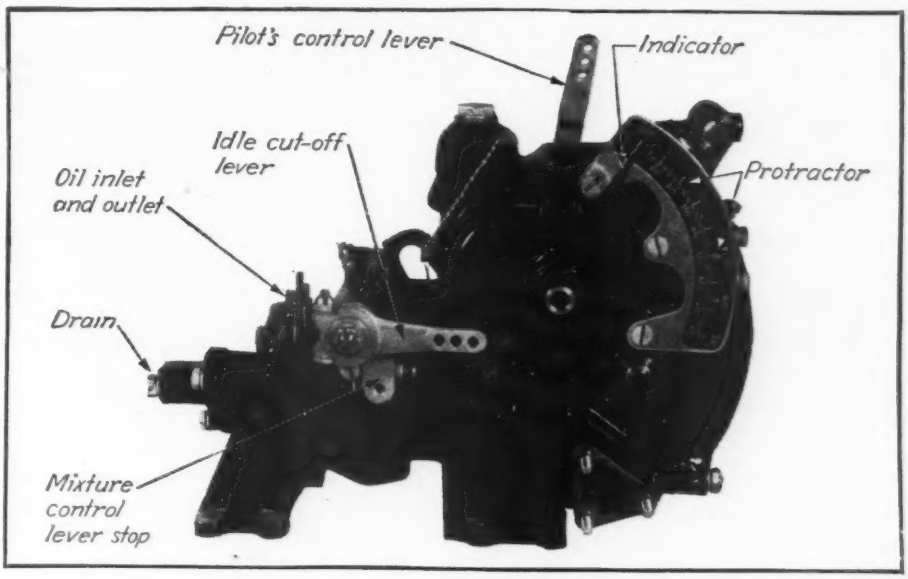


Fig. 3. Simmonds-Hobson automatic engine control which regulates both manifold pressure (boost) and mixture.

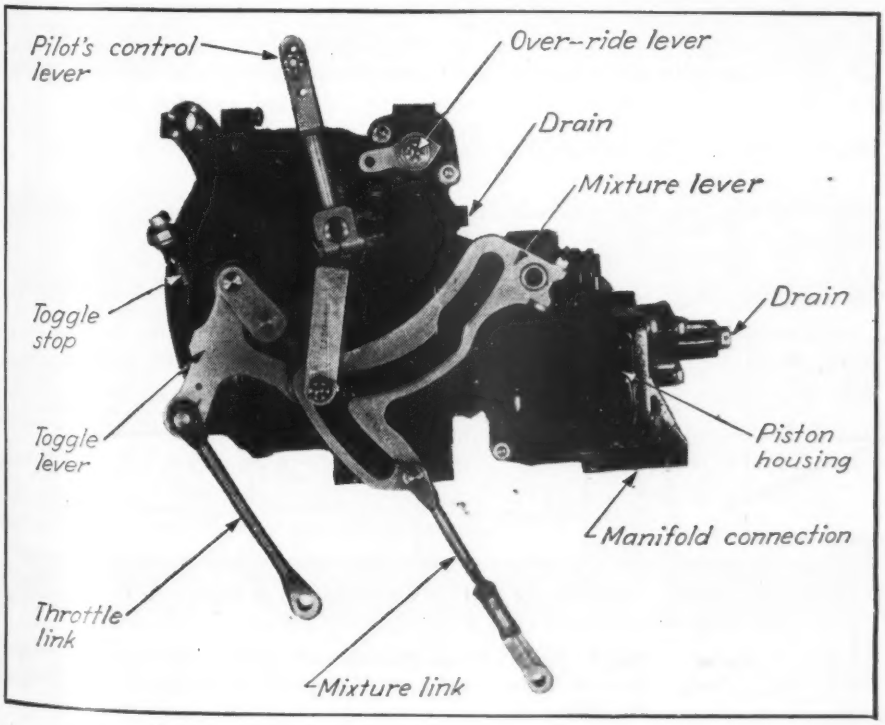


Fig. 4. Reverse side of control shown in Fig. 3.

move up the bottom end of the capsule. One end of the capsule is attached to the valve so that it is also moved up and oil under pressure is ported to the topside of the piston, causing it to move downward. Drain passages are provided as shown around the valve in Fig. 2a, and the capsule chamber is vented to the intake manifold.

If the end of the capsule is set to a particular position, the unit will maintain the manifold pressure to a constant value corresponding to that position. For, if the manifold pressure exceeds the equilibrium value, the pressure in the capsule chamber will rise, the capsule will contract, draw the valve up, and supply oil to the topside of the piston. The piston will move downward, closing the throttle valve until the manifold pressure drops sufficiently to allow the capsule to expand and push the valve to the equilibrium position.

"Hunting" is avoided by adjusting the width of the valve lands and the piston diametral clearance to values which permit an appreciable oil flow. (The pilot would still have mechanical control over the engine, if the unit were damaged by gunfire.)

Auto-Boost and Mixture Control

Experience with the simpler type control described above showed the desirability of giving the pilot a throttle control lever which he could set for takeoff, rated, or maximum cruising manifold pressure immediately without watching his instruments. Of course, it should also be possible for the pilot to obtain any manifold pressure intermediate between these values. To simplify installation and maintenance, the control should be a self-contained unit which can be adjusted and accurately set on a test bench so that for every position of the pilot's throttle control lever the unit would maintain a particular manifold pressure.

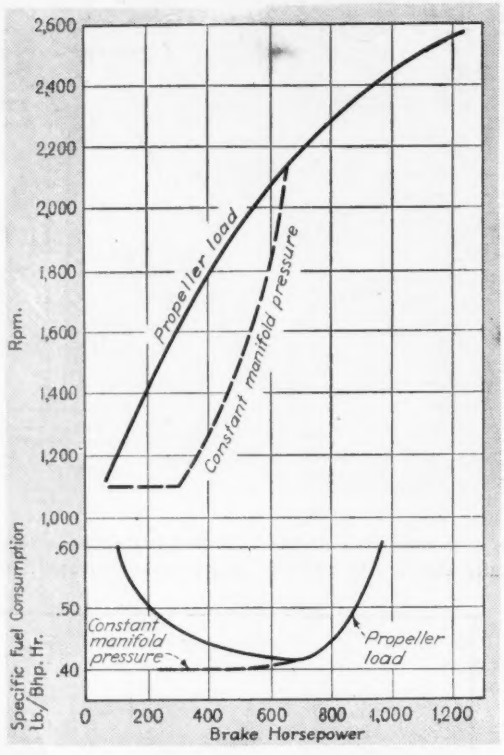


Fig. 5. Specific fuel consumption and rpm. as function of power output for both propeller load and constant manifold pressure operation.

A second type automatic engine control was developed to meet these requirements. The schematic diagram in Fig. 2b shows that the basic capsule, valve, and servo piston are again employed. The pilot's throttle control lever is connected so that it rotates shaft *A*. Two cams are mounted on this shaft. Cam *C* operates lever *F* rigidly mounted on shaft *B*. Shaft *A* rotates so that, as the pilot moves his throttle lever toward the open position counter clockwise, shaft *B* rotates clockwise. The lever arm *E* mounted on shaft *B* operates link *T* to move the throttle valve toward the open position.

This arrangement gives the pilot mechanical actuation of the throttle for taxiing purposes. It also gives a relatively large quadrant movement for small carburetor throttle openings for taxiing. However, the cam is profiled to give a sea-level manifold pressure which is considerably less than that normally desired for each particular position of the pilot's throttle lever above the idle range.

The servo piston then moves upward to act on link *T* to increase the throttle opening to the desired value. The capsule and valve act in much the same general way as in the previously described unit. A second cam *D* rigidly attached to shaft *A* determines the position of the top of the capsules, and hence the manifold pressure at which they will move the valve to a neutral position. The servo piston will act to maintain this manifold pressure.

Cam *D* is made in three sections with a "dwell" between each so that in the vicinity of three positions no change in the capsule setting will occur. Thus the pilot can tell from the "feel" of his control lever when it is set to maximum cruising, rated, or takeoff manifold pressure as he moves the throttle lever from the closed to the open position.

Fig. 3 shows a view of this type control. The quadrant shown is centered on shaft *A* of Fig. 2b. It is provided to aid in checking adjustments, etc. Note that shaft positions for "economical cruising boost", "rated boost", and "takeoff boost" are marked on the protractor for shaft *A* with the letters *ECB*,

(*Turn to page* 257)

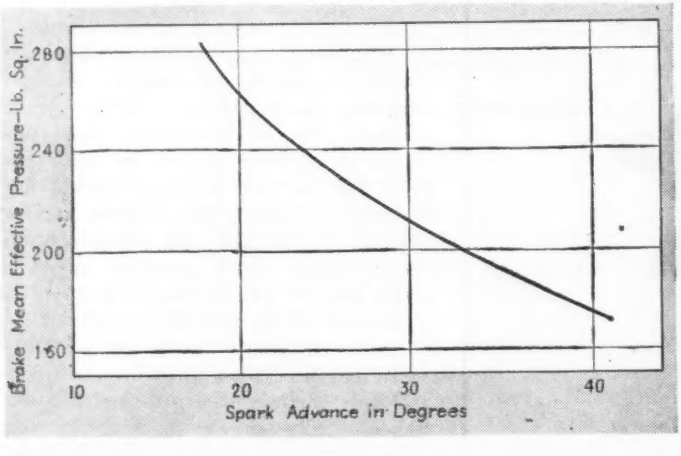


Fig. 6. Effect of spark advance on maximum b.m.e.p. with rich mixtures for a hypothetical engine. (Computed from NACA Tech. Report No. 655.)

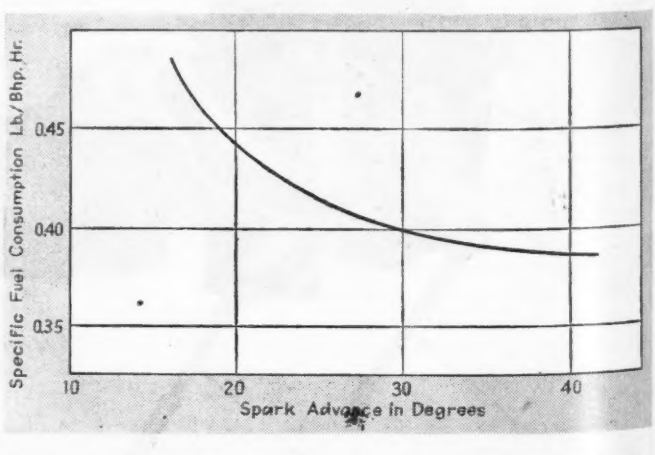


Fig. 7. Spark advance effect on best economy specific fuel consumption for engine in Fig. 6. (Computed from NACA Tech. Report No. 655.)

The B.F. Goodrich Airplane of the month

GRUMMAN HELLCAT

WATCH THE HEADLINES as the name "Hellcat" is written into the history of this war. You'll read it, and it will be good reading . . . for everyone but the Axis. For this sensational Grumman fighter—designated F6F—is our Navy's newest form of sudden death with wings. It's at home on land or on a carrier's deck. And like its famous predecessor, the "Wildcat," this new speedster will also be one of the British Navy's standard fighters.

We're proud that Silvertown Tires, De-Icers, Bullet Sealing Fuel Cells, and many other B. F. Goodrich products are helping manufacturers like Grumman make American warplanes the best in the world. To one of these planes, the Grumman "Hellcat," —our nomination as Plane-of-the-Month.

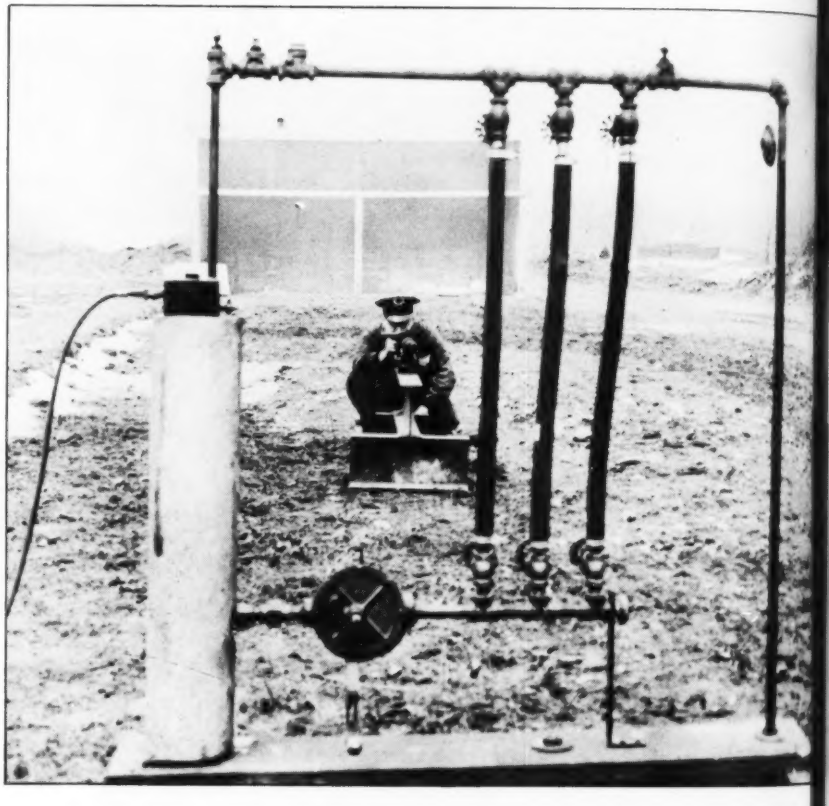
In war or peace

B.F.Goodrich

FIRST IN RUBBER

B.F.GOODRICH RUBBER RESEARCH FOR THE *Aviation industry*

HE'S SHOOTING HOLES IN A HOSE . . . TO HELP BRING OUR FIGHTERS HOME



IT'S A mighty important hose he's shooting at, and it's mighty important that he score plenty of hits. For this hose is the vital link between an airplane's fuel tanks and its engines . . . a link whose failure due to bullet punctures, shell fragments, or any other cause could mean the loss of plane and crew. That's why he wants his 50 calibre bullets to hit and hit again . . . to see if the hose can take it.

And it can. This newest type of B. F. Goodrich Bullet-Sealing Fuel Hose has stood the firing tests both on the range and in combat. Time and again it has been shot up by 30's and 50's without fuel leakage. Actual cases are on record where good sized shell fragments have been found imbedded in the fuel hose of planes safely home from battle.

Back in 1941 was when B. F. Goodrich first began producing bullet-sealing fuel hose . . . following many months of development work. The original construction consisted of an Ameripol (synthetic rubber) tube, sealing layers, reinforcing plies, and an Ameripol cover. When gasoline penetrated the tube through any puncture, it caused the sealing layers to swell and thus seal the puncture.

Much research and many more developments followed, due to constantly changing performance requirements. The advent of aromatic fuel was responsible for one of the recent developments. This new fuel caused greater swelling and deterioration of the tube compound, hence construction utilizing an aromatic-resistant compound was needed. The first one developed did an excellent job of sealing at normal temperatures; but at the sub-zero temperatures encountered in arctic and high-altitude operations, its sealing effectiveness diminished.

It therefore became necessary to develop still another construction utilizing a compound that would swell enough at sub-zero temperatures to seal efficiently yet not swell so much at normal temperatures that the inside diameter would be severely restricted. A construction of this type, with a few minor changes, has been in production since early 1942.

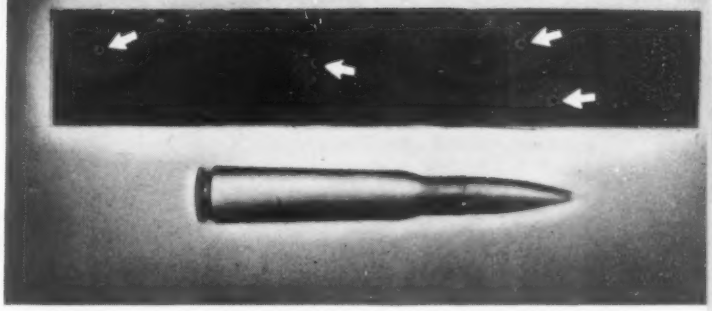
It is interesting to note that over 300 different constructions were made up and subjected to firing tests before today's efficient B. F. Goodrich Bullet-Sealing Fuel Hose was produced. And even now, B. F. Goodrich engineers continue their research, looking for still greater sealing efficiency . . . still greater protection for our combat fliers all over the world.

MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

ARMY E NAVY
Awarded to seven plants

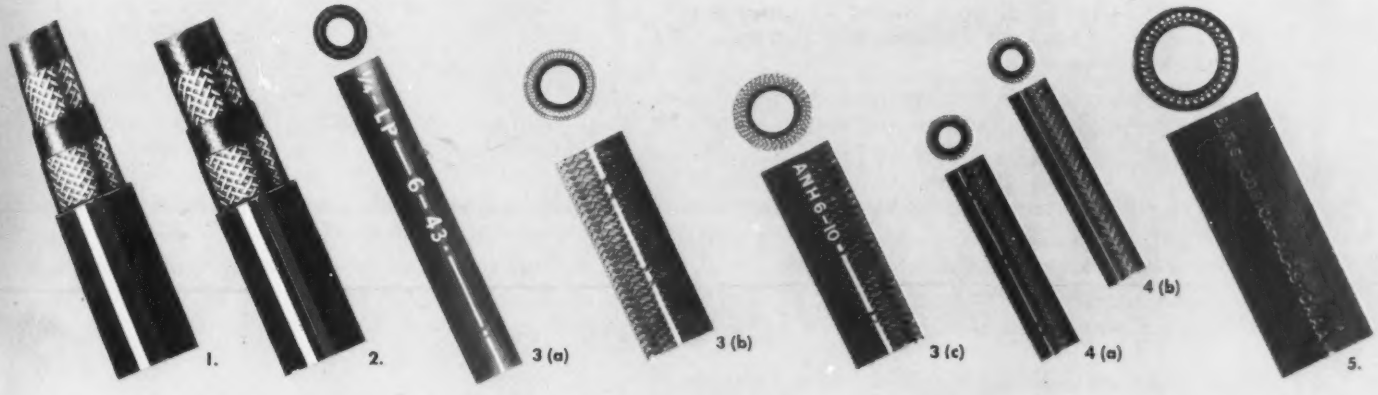
THERE'S AN EFFICIENT B. F. GOODRICH HOSE FOR EVERY AIRCRAFT APPLICATION

BULLET-SEALING FUEL HOSE



SCHEMATIC CROSS SECTION drawing of basic elements and side view showing identification markings. Designed for maximum sealing efficiency, this hose meets latest Army and Navy requirements and is approved for Army and Navy aircraft.

HERE'S PROOF of sealing efficiency: Although this small section of hose was punctured four times by .50 calibre machine gun bullets (shown in same scale below) it held fuel under 10 to 15 pounds pressure without leaking.



ALL B. F. GOODRICH HOSE CLEARLY MARKED FOR QUICK IDENTIFICATION

1. AIRCRAFT HOSE: All-purpose hose suitable for fuel systems. Meets latest revisions of Army-Navy specification AN-ZZ-H-456A. Identified by one broken red and one solid white stripe.

2. OIL AND COOLANT HOSE: Made with new Neoprene compound to meet coupling conditions encountered in oil and coolant service. Otherwise similar to (1) above. Solid red and solid white stripe.

3. (a, b, c) HYDRAULIC AND INSTRUMENT HOSE: (Note: This group compounded for use in working conditions as low as –70° F. Identified by code ·—·– as B. F. Goodrich low temperature resistant.)

(a) **SPEC. ANZZH626A LOW PRESSURE INSTRUMENT HOSE:** For use on air, hydraulic, low pressure and fuel lines up to 40% aromatic.

(b) **SPEC. ANZZ623A HIGH PRESSURE HOSE:** Available both in synthetic and braided cover.

(c) **SPEC. ANH6a MEDIUM PRESSURE HOSE:** Air Corps standard for both medium and high-pressure service.

4. OXYGEN BREATHING HOSE: (a) Low Pressure—broken green stripe; (b) High Pressure—solid green stripe.

5. FIRE PREVENTIVE HOSE: For use ahead of engine fire wall in commercial planes. CAA-approved. Aromatic-resistant.

NEW DATA SHEETS AVAILABLE: Contain the facts you'll want (sizes, thicknesses, weights, lengths available, etc.) on the complete line of B. F. Goodrich Airplane Hose. For your free copy, write today (on company letterhead, please) to The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

In war or peace

B.F.Goodrich

FIRST IN RUBBER

GEORGIE GREMLIN WASHED OUT ON THIS

DE-ICER SERVICE QUIZ

CAN YOU SCORE 100%?

Complete the ten statements by simply picking the one correct part (a, b or c) following each numbered statement. See if you can get them all.

1. During every preflight inspection, De-Icers should be checked for punctures, loose patches and for freedom from oil because . . .

a. The crew chief says so.
b. Punctures admit too much sunlight.
c. It insures successful operation.

2. Soapstone or talc is applied between the De-Icer and wing skin . . .

a. To act as an insulator.
b. To fill in cracks.
c. To act as a lubricant.

3. Any oil found on De-Icers should be removed as soon as possible with a neutral soap and water solution because . . .

a. De-Icers don't need outside lubrication.
b. Oil is extremely harmful to rubber.
c. Someone might slip and break his neck.

4. If any damage to the De-Icer—large or small—is discovered . . .

a. Find out who caused the damage.
b. Make sure the hydraulic system is full.
c. Ground plane until De-Icer repair is made.

5. Except in emergencies, the standard B.F. Goodrich De-Icer Repair Kit should be used for surface breaks whose length is . . .

a. Three-quarters of an inch or less.
b. Three inches or less.
c. Five inches or less.

6. Only the materials in the B. F. Goodrich De-Icer Repair Kit should be used because . . .

a. De-Icers must be repaired with specially compounded rubber.
b. These materials are gremlin-proof.
c. Other materials are more expensive.

7. Whenever possible, a vulcanized repair is best for large surface breaks because . . .

a. A vulcanized repair uses less rubber.
b. It is stronger, neater and lasts longer.
c. It can be done quicker.

8. Adhesive tape is applied to the underside of each fairing strip's trailing edge to . . .

a. Prevent marring the skin of the airplane.
b. Carry inspection data.
c. Show manufacturer's code number.

9. For most efficient operation, the De-Icer pressure gauge should read 8 lbs. per sq. in. because . . .

a. This pressure keeps the plane balanced.
b. This pressure keeps oil flowing freely.
c. This pressure is necessary for proper inflation of the tubes without danger of rupture.

10. A complete cycle of De-Icer inflation should take approximately 40 seconds because . . .

a. Perfect timing shakes off chisel-jawed gremlins.
b. A 40-second cycle permits ice to form and be cracked off most efficiently.
c. A faster cycle might cause wing flutter.

WHAT IS YOUR SCORE?

Each correct answer counts 10. 1-c, 2-c, 3-b, 4-c, 5-a, 6-a, 7-b, 8-a, 9-c, 10-b.

FREE! Pocket-size booklet on De-Icer Servicing and Installation! Every trainee and instructor who works with De-Icers will want a copy of this interesting and informative booklet. Completely illustrated with step-by-step drawings, it shows the correct procedures for removing, repairing, storing and re-installing De-Icers. For your free copy of "De-Icer Service and Installation," write today to the B. F. Goodrich Company, Akron, Ohio.

B. F. GOODRICH, AERONAUTICAL DIVISION, AKRON, O.

Skyway or Highway

B.F.Goodrich

FIRST IN RUBBER

Prescriptions for Head Cracks In 24ST Rivets

By E. C. HARTMANN, C. F. WESTCOAT, M. W. BRENNECKE
Aluminum Research Laboratories

Laboratory tests of strengths, corrosion resistance, heat treatments, and aging of rivets give a five-point guide to new efficiencies in their employment in aircraft.

RIVETS of 24ST aluminum alloy used in the construction of aircraft, are especially employed in highly stressed parts, because they are the strongest of the commercial aluminum alloy rivets. They are, however, the most difficult to drive. Rivets of this alloy age-harden rapidly at room temperature after heat treatment and consequently become more difficult to drive as the interval of room temperature aging between heat treatment and driving increases. Therefore, the rivets should be driven promptly after heat treatment, or they should be refrigerated immediately after heat treatment to retard aging, then driven promptly after removal from the refrigerant.[1]

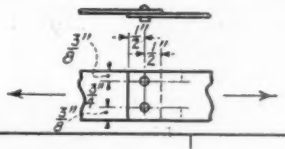
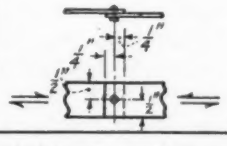
[1] B. J. Fletcher, Refrigerating Aluminum Alloy Rivets and Parts, p. 1178, *Metals and Alloys*, June '43.

Although these procedures are usually closely followed in practice, cracks sometimes develop in the driven heads, resulting from the fact that the rivets have only a limited capacity to withstand plastic deformation without rupture, even when handled under ideal conditions. When this limited capacity is further decreased by excessive room temperature aging or faulty heat treatment, the amount of upsetting that the rivet will withstand may be less than that required to form the desired size of driven head. The cracks extend radially into the head and usually are inclined to the surface of the sheet. Because the two edges of the crack appear to have slipped or "sheared" over each other, head cracks of this character are often referred to as *shear cracks* to distinguish them from the less common radial splitting of the head sometimes resulting from a seam or other longitudinal defect in the wire, from quench cracks that occur in overheated material, or from the cracking that is associated with grain boundary melting. Shear cracks, rather than the other types of cracks or splits, are the subject of this article.

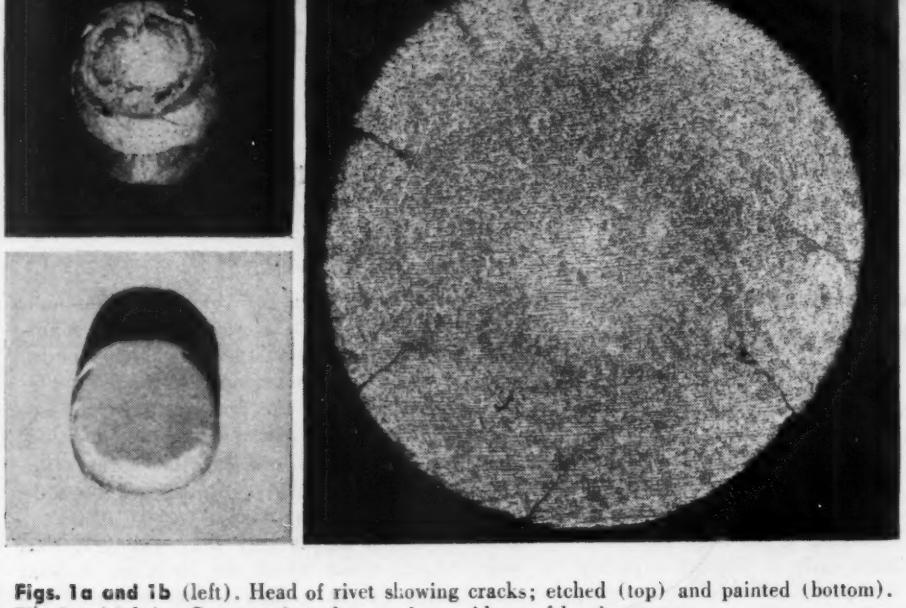
Head cracks may vary widely in size, from those which are invisible without the aid of a lens to those which are plainly visible to the most inexpert eye and which seriously disfigure the rivet head. A wide range in degree of cracking was observed in the tests to be described. Fig. 1 shows cracks classified as severe which are plainly visible even after a coat of paint has been applied to the rivet head. Cracks even more pronounced than these were obtained in some of the specimens.

When head cracks in driven rivets are found in airplane structures, the rivets are often rejected, drilled out, and replaced by new rivets. This procedure is costly, time consuming, and of doubt-

TABLE 1—Effect of Cracks in Driven Head on Static and Fatigue Strength of 1/2-in. 24ST Rivets.

Type of test	Type of specimen		Rivets Without Head Cracks			Rivets With Head Cracks		
			Number of tests	Average load per rivet at failure, lb.	Average strength,* Psi.	Number of tests	Average load per rivet at failure. lb.	Average strength,* Psi.
Static tension			4	908	68,800	15	929	70,100
Static shear			9	581	44,500	12	618	47,300
Shear fatigue, complete reversal of stress, †		1 Million cycles	–	185	14,100	–	185	14,100
		100 Million cycles	–	120	9,200	–	120	9,200

* *Strengths based on area of hole.*
† *Values taken from smooth curve drawn through plotted data points in Fig. 3.*



Figs. 1a and 1b (left). Head of rivet showing cracks; etched (top) and painted (bottom). **Fig. 1c** (right). Cross section of same rivet, midway of head.

TABLE II—Effect of Various Heat-Treating Temperatures and Aging Times on Shear Strengths and Driving Characteristics of ¼ in. 24ST Rivets (Flatheads).

All rivets 7/16 in. long for grip of 3/16 in., holes 0.257 in. dia.

Heat Treating Temp. Deg. F.	1-Min. Room Temperature Aging Before Driving		45-Min. Room Temperature Aging Before Driving		1-Wk. Room Temperature Aging Before Driving		Approximate Beginning of Head Cracking		
	Driving Pressure,* Lb.	Shear Strength,† Psi.	Driving Pressure,* Lb.	Shear Strength,† Psi.	Driving Pressure,* Lb.	Shear Strength,† Psi.	Interval of Room Temp. Aging, Min.	Driving Pressure, Lb.	Shear Strength,† Psi.
Initial Heat Treatment, Dia. of Driven Head, 0.375 in.									
850	7,300	34,600	7,900	34,600	.....	.....	200	8.5	
875	8,000	37,100	8,000	37,100	.....	.....	100	8,600	37,100
900	8,800	41,300	9,700c	43,100	.....	.....	30	10,000	41,900
920	9,500	43,800	9,500c	44,100	.....	.....	10	10,000	43,900
940	9,500	46,500	11,200c	45,700	.....	.....	3	9,400	46,000
960	9,500c	42,500	10,200c	41,800	.....	.....	0	9,500	42,500
Rivets Reheat-Treated at Temperatures Indicated below, after Initial Heat Treatment at 920 Deg. F. and 1 Wk. Room Temperature Aging. Dia. of Driven Head, 0.375 in.									
850	7,800	37,900	8,300	36,200	.....	.....	150	8,400	37,000
875	8,300	38,500	8,500	39,100	.....	.....	75	8,900	39,700
900	9,400	42,700	9,800c	43,300	.....	.....	40	9,700	43,200
920	9,500	44,100	10,200c	45,000	.....	.....	20	10,000	44,900
Initial Heat Treatment, Dia. of Driven Head = 0.333 in.									
900	6,400	40,300	6,700	40,500	8,000c	44,000	300	7,800	42,500
920	6,800	42,900	7,500	43,000	8,300c	44,500	150	7,800	43,500

* Letter "c" after driving pressure indicates driven heads cracked.

† Shear Strength based on area of hole (shear area per rivet = $\pi/4 \times \overline{0.257}^2 = 0.052$ sq. in.)
All rivets tested 1 wk. after heat treatment.

ful efficacy. The new rivets may not show head cracks, but the job often is of poorer quality than the original because of the out-of-round holes and other damage resulting from removing the cracked rivets. Therefore, it is wise to examine closely the reasons for condemning the cracked rivets. In another publication[2] it was shown that head cracks were harmless to the static strength of 17S rivets. We will demonstrate that not only is the same true of 24ST rivets, but also that head cracks do not adversely affect shear fatigue strengths and do not appreciably reduce resistance to corrosion. This article and the one just referred to, by showing the harmless nature of head cracks, offer arguments against unreasonable rejections and replacements of rivets showing head cracks during driving.

Even though such cracks are structurally harmless, precautions should, of course, be taken to avoid them because of their poor appearance. To this end data are included on the effect of heat-treating temperature, interval of room temperature aging, and size of driven head on the cracking tendencies of rivets. Incidentally, our article offers considerable data on the static and fatigue strengths of driven 24ST rivets, and attention is called to the fact that the strengths of the driven rivets are here based on tensile and shear areas equal to the areas of the rivet holes. Had the strengths been based on the nominal areas of the shanks of the undriven rivets, as is often done in practice, the strengths would all be increased by about 6 percent.

Effect on Strength and Corrosion Resistance of Driven Rivets

Tests in our static tensile strength investigation were made on ⅛-in. button-head 24ST rivets driven in steel fixtures of the type illustrated in Table I. Holes in the various individual fixtures varied slightly in diameter but averaged about 0.130 in. Total grip for the rivets was ¼ in. The rivets were heat treated for about 30 min. at 920 deg. F., quenched in cold water, immersed in ice water at about 35 deg. F., and squeeze driven with flat heads after short intervals of room temperature aging following removal from the ice water.

Cracked and uncracked heads were produced on rivets (from a single lot) simply by varying the driving pressure and the interval of room temperature aging before driving. The driven heads varied in thickness from about 0.060 to 0.080 in. and in diameter from about 0.180 to 0.210 in. and the driven rivets were tested in an Amsler hydraulic testing machine of 40,000 lb. capacity using a load range of 0 to 4,000 lb. The steel fixtures were threaded into steel receptacles which were pulled apart by means of spherically seated tension bolts coaxial with the rivet. In general, failures were by tensile fracture of the shank of the rivet. In no case was the failure associated with cracks in the rivet head.

Tensile strengths of the rivets without head cracks, based on the cross-sectional area of the holes in the steel fixtures, varied from 67,000 to 70,000 psi., with an average of 68,800. Tensile strengths of the rivets with head cracks varied from 66,300 to 75,000, with an average of 70,100 psi. Table I summarizes the results, indicating clearly that head cracks are harmless to the static tensile strengths of driven rivets.

Fact that, in general, the rivets with cracked heads show higher strengths than those with uncracked heads should not be considered as having any special significance because the factors which induce head cracking also generally increase the strength of the driven rivets. Those rivets which were cracked were the harder rivets driven with the higher pressures; and, since the head cracks did not operate to reduce the strength,

[2] F. V. Hartman, F. E. Rebhun, and D. A. Paul, The Effect of Head Cracks upon the Strength of Aluminum Alloy Rivets, published by Aluminum Co. of America, '41.

these rivets, of course, were slightly stronger than those with less aging and driven with less pressure. This reasoning applies not only to this comparison of static tensile strengths but also to the comparison of static shear strengths that follows.

Static shear tests were made on $\frac{1}{8}$ in. button-head 24ST rivets driven in lap joints of 0.064 in. 24ST sheet. Each specimen contained two rivets arranged as indicated in the sketch in Table I. All holes were of 0.129 in. dia. Heat treating, quenching, refrigerating, and driving of the rivets were the same as in the case of the static tensile tests. The joints were tested using a 40,000 lb. capacity Amsler testing machine. All failures were by shearing of the rivets.

Shear strengths of the rivets without head cracks varied from 42,600 to 45,000 psi., with an average of 44,500, as contrasted to values of 44,600, 48,300, and 47,300 for the rivets with cracked heads. Table I again summarizes the results and indicates clearly that head cracks are harmless to the static shear strengths of driven rivets.

Shear fatigue tests were made on rivets from the same lot as used for the static shear tests, driven in lap joints of the same sheet. Test panels were prepared by joining two sheets with a single row of rivets at the center of a lap of $\frac{1}{2}$ in. These panels were cut into 1 in. wide strips of the type shown in Table I, each containing a single rivet at the center. The rivet holes were of 0.129 in. dia. Heat treating, quenching, refrigerating, and driving of the rivets were the same as in the preparation of the static tensile specimens.

Tests were made in a pair of rotating-beam fatigue machines (shown in Fig. 2) designed and built at Aluminum Research Laboratories for this type of testing. Sets of four of the 1 in. wide lap joints, each containing a single rivet, were fastened across a $1\frac{3}{8}$ in. gap between a pair of flanged steel holders. The holders with four joints in place, 90 deg. apart, were subjected to a steady bending moment and rotated about their axis at 1,750 rpm. With every revolution of the holders, each joint was subject to completely reversed stresses tending to shear the rivet. The load producing the steady bending moment on the holders was applied and maintained by means of a calibrated steel spring.

Fig. 3 gives the results of the fatigue tests. In general, the failures were by shear of the rivets, although in a few cases tensile fatigue fracture of the sheets through the rivet holes was encountered. While there is some scatter of the data, the plotted points for both cracked and uncracked heads seem to define a single fairly smooth curve. It is evident from Fig. 3 that head

TABLE III—Effect of Size of Driven Head on Strength of Single Riveted 24ST Lap Joints Made With $\frac{1}{8}$ in. 24ST Rivets.

All rivets driven (flatheads) in 0.1285 in. holes. Interval of room temperature aging before driving, 1 min. Interval of room temperature aging before testing, 1 wk. Each strength is average of results of five tests.

Average Sheet Thickness, In.	Ratio of Head to Shank, Dia.	Average Ultimate Load, Lb.	Corresponding Bearing Stress,* Psi.	Corresponding Shear Stress,† Psi.	Predominant Type of Failure
0.0194	1.10	202	81,000	15,500	Driven head pulled through sheet.
0.0251	1.10	282	87,400	21,700	Driven head pulled through sheet.
0.0322	1.10	379	91,600	29,200	Driven head pulled through sheet.
0.0407	1.10	500	95,600	38,500	Rivet sheared.
0.0194	1.20	230	92,300	17,700	Driven head pulled through sheet.
0.0251	1.20	330	102,300	25,400	Driven head pulled through sheet.
0.0322	1.20	453	109,500	34,800	Driven head pulled through sheet.
0.0407	1.20	529	101,100	40,700	Rivet sheared.
0.0194	1.30	241	96,700	18,500	Sheet tore part way to edge.
0.0251	1.30	342	106,000	26,300	Sheet tore part way to edge.
0.0322	1.30	502	121,300	38,600	Driven head pulled through sheet.
0.0407	1.30	541	103,400	41,600	Rivet sheared.
0.0194	1.40	258	103,500	19,800	Sheet tore all the way to edge.
0.0251	1.40	372	115,300	28,600	Sheet tore all the way to edge.
0.0322	1.40	527	127,400	40,500	Mixed**
0.0407	1.40	567	108,400	43,600	Rivet sheared.
0.0194	1.50	279	111,900	21,500	Sheet tore all the way to edge.
0.0251	1.50	411	127,400	31,600	Sheet tore all the way to edge.
0.0322	1.50	540	130,500	41,500	Sheet tore all the way to edge.
0.0407	1.50	587	112,200	45,100	Rivet sheared.

* Bearing area = hole dia. × sheet thickness = dt = 0.1285t.
† Shear area = $\pi d^2/4$ = 0.013 square inch.

** Driven head pulled through sheet in two cases (sheet tore part way to edge in one case, all the way to edge in two cases).

cracks are harmless to the shear fatigue strengths of driven rivets.

Corrosion tests were made on $\frac{1}{8}$ in. 24ST rivets driven in two 0.064 in. sheets. In some cases the sheets were 24ST, in others 24ST Alclad. Heating, quenching, refrigerating, and driving of the rivets were the same as in the static tensile tests. Half the specimens had rivets with cracks in the driven heads; the remaining specimens had rivets free from cracks.

The specimens were subjected to three different conditions of accelerated corrosion: (1) alternate immersion in a solution of sodium chloride and hydrogen peroxide, (2) immersion in a solution of sodium chloride-sodium chrom-

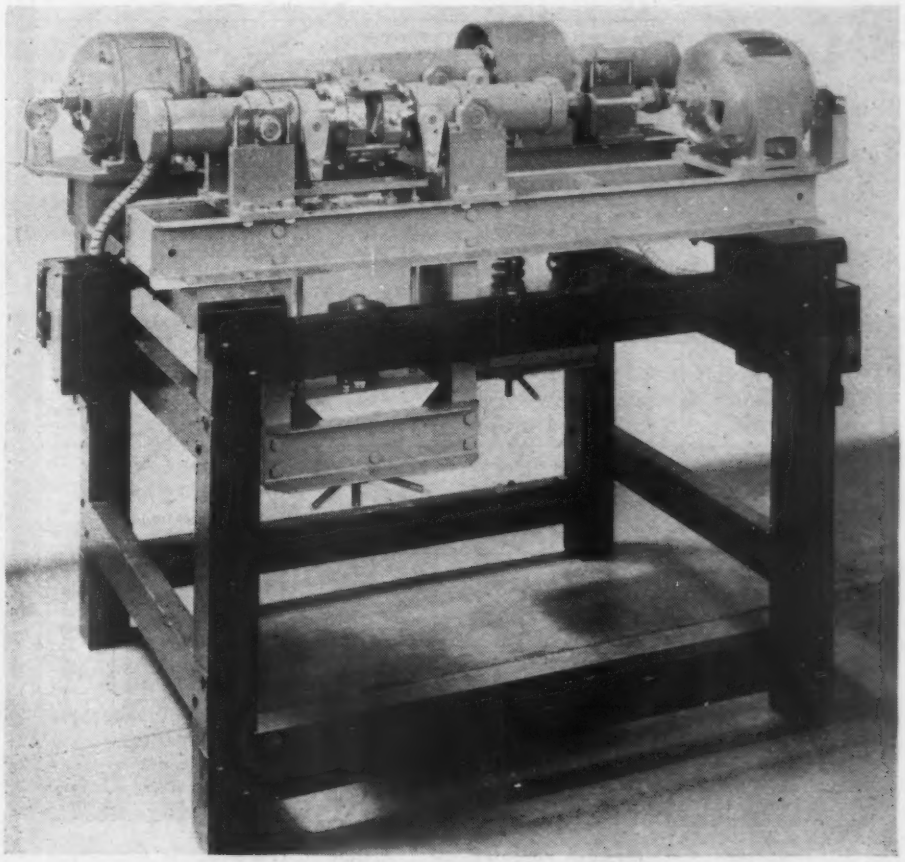


Fig. 2. Rotating beam fatigue machine for testing riveted joints.

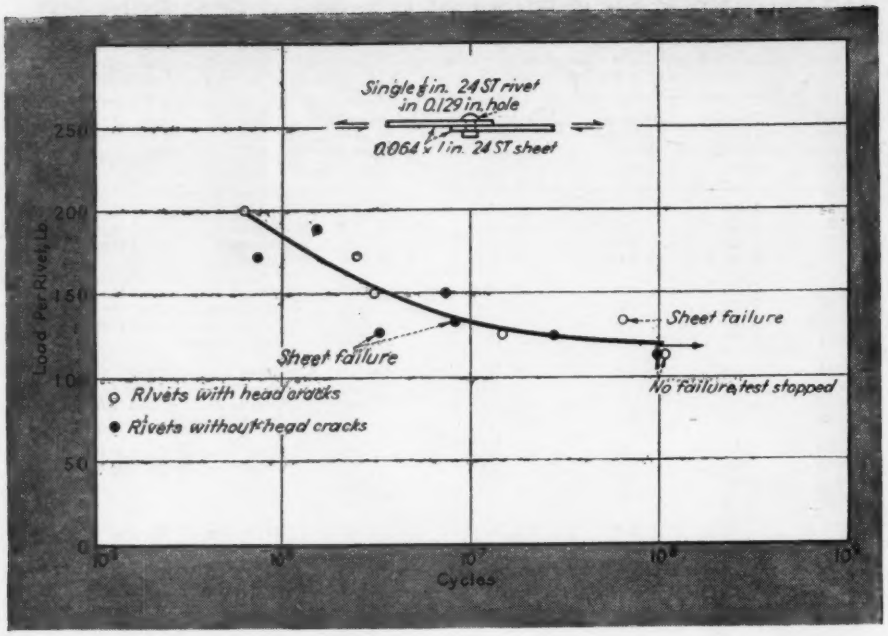


Fig. 3. Effect of head cracks on shear fatigue strength of ⅛ in. 24ST rivets. All tests made with complete reversal of stress, and all failures by shear, except as noted.

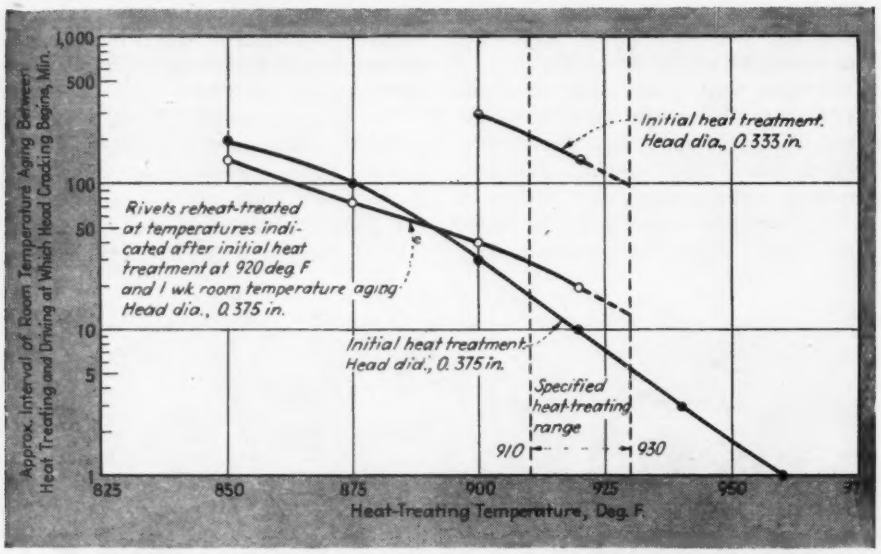

Approx. Interval of Room Temperature Aging Between Heat Treating and Driving at Which Head Cracking Begins, Min.
Initial heat treatment. Head dia., 0.333 in.
Rivets reheat-treated at temperatures indicated after initial heat treatment at 920 deg. F and 1 wk. room temperature aging. Head dia., 0.375 in.
Initial heat treatment. Head dia., 0.375 in.
Specified heat-treating range
910
930
Heat-Treating Temperature, Deg. F.

Fig. 4. Heat-treating temperature effect on head cracking.

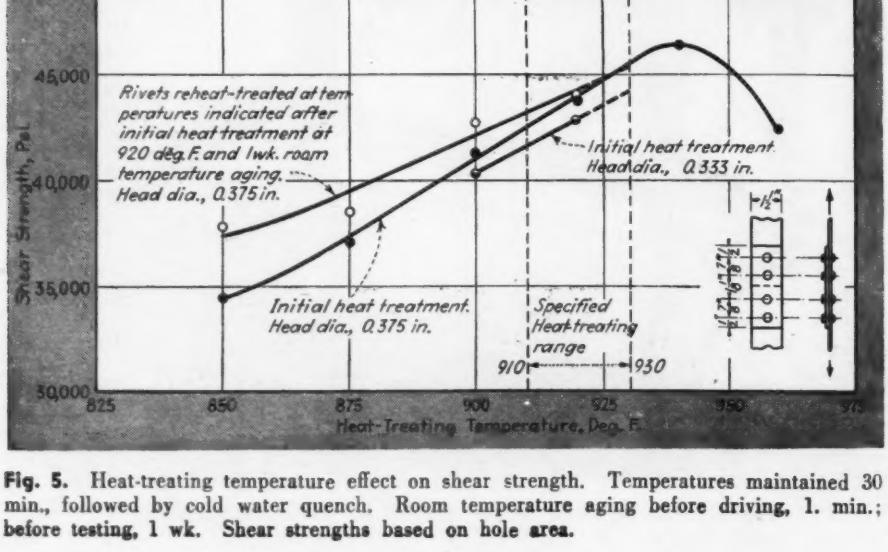

Shear Strength, Psi
Rivets reheat-treated at temperatures indicated after initial heat treatment at 920 deg. F and 1 wk. room temperature aging. Head dia., 0.375 in.
Initial heat treatment. Head dia., 0.333 in.
Initial heat treatment. Head dia., 0.375 in.
Specified Heat-treating range
910
930
Heat-Treating Temperature, Deg. F.

Fig. 5. Heat-treating temperature effect on shear strength. Temperatures maintained 30 min., followed by cold water quench. Room temperature aging before driving, 1. min.; before testing, 1 wk. Shear strengths based on hole area.

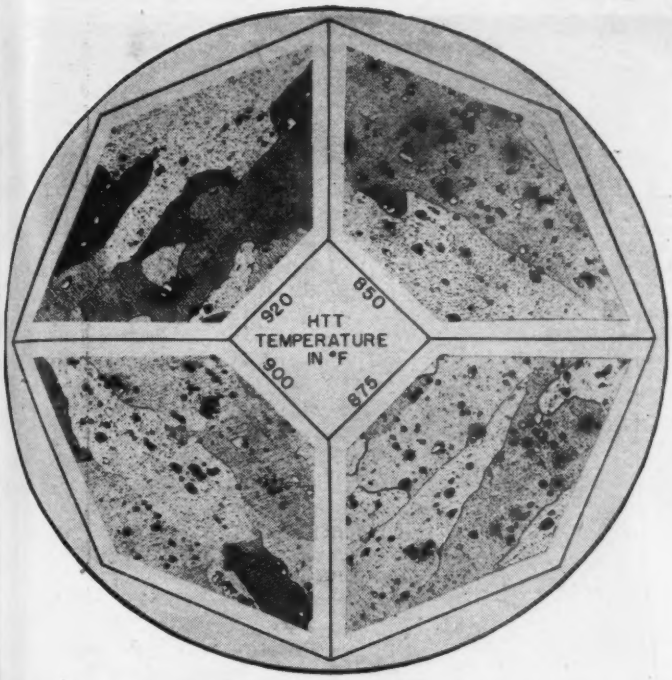
ate, and (3) intermittent salt spray. The first of these exposures was continued for two weeks, after which there was a complete examination comparing the cracked rivets with the uncracked rivets. Microscopic check showed the type and severity of the corrosion on the exposed surfaces to be the same in both cracked and uncracked rivets. The cracks represent additional exposed surface, and about the same type and severity of corrosion proceeded along them as occurred on the external surfaces. After five weeks' exposure to the second and third conditions, the specimens exhibit no differences in behavior between the cracked-head rivets and those free from head cracks.

Effect of Heat-Treating Temperatures and Intervals of Aging

Tests in this part of the investigation were made on ¼ in. x 7/16 in. button-head 24ST rivets squeeze driven in single shear joints (of type indicated in Fig. 5) composed of 3/32-in. 24ST sheet. The holes were of 0.257 in. dia. Rivets were heat treated for 30 min. at various temperatures, quenched in cold water, immersed in ice water, and driven with various intervals of room temperature aging after removal from the ice water. All driven heads were flat. About 350 rivets were driven using 6 different heat-treating temperatures and 21 different intervals of room temperature aging, ranging from 1 min. to 1 wk. Interval of room temperature aging before testing was 1 wk.

Results of this investigation are shown in condensed form in Table II and in Figs. 4, 5, and 6. It is evident from Table II and Fig. 4 that within the temperature limits here investigated the tendency for head cracking is reduced by lowering the initial solution heat-treating temperature. Table II and Fig. 5, however, show that a decrease in initial solution heat-treating temperature also reduces the shear strength of the rivets. These facts are largely of academic interest, however, because commercial 24ST rivets, in accordance with specifications, are shipped to the user only after they have received their initial heat treatment by the rivet manufacturer. The heat-treating temperature used for this initial heat treatment is, of course, always within the specified range, 910 deg. to 930 deg. F.

Rivets of 24ST are always reheat-treated by the user. It appears from Table II and Figs. 4 and 5 that reheat-treatment at the same temperature level as the initial heat treatment does not adversely affect head cracking or shear strength of the rivets. When, however, a temperature much below this level is employed in reheat-treatment the shear strength is lowered. This effect is related to changes in microstructure that occur when 24ST is re-



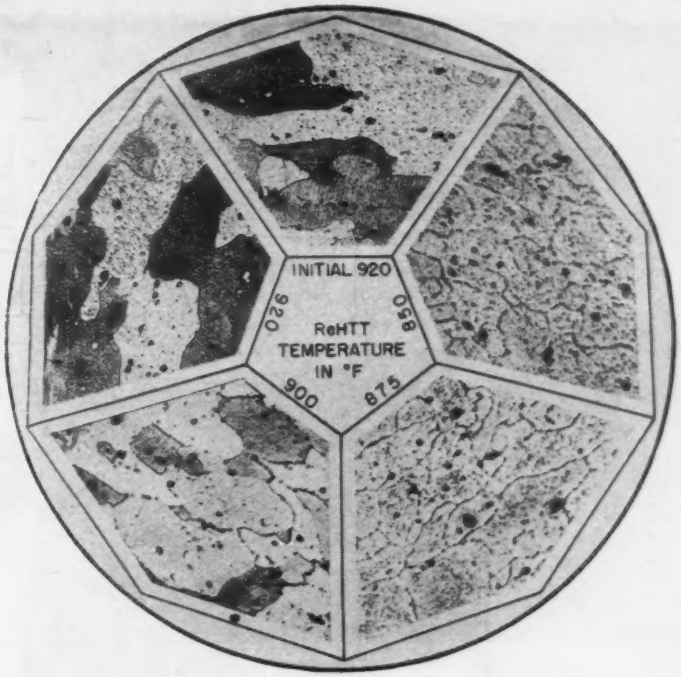


Fig. 6a (left). Effect of solution heat-treating temperature on microstructure of 24ST rivets. **Fig. 6b** (right). Effect of reheat-treatment on microstructure of 24ST rivets, initially heat-treated at 920 deg. F. All treatments 30 min. and with cold water quench.

heat-treated at temperatures below the initial heat-treating range. Effect of initial heat-treating temperature on the microstructure of 24ST rivets is illustrated by Fig. 6a. For comparison, the microstructures obtained for 24ST rivets reheat-treated at the various temperatures are shown in Fig. 6b. Microstructure of 24ST reheat-treated at temperatures more than 20 deg. F. below the initial heat-treating temperature shows evidence of considerable precipitation of previously dissolved constituents along the grain boundaries. Material in this condition not only has reduced strength but is known to have unsatisfactory resistance to corrosion.

Heat-treating or reheat-treating of 24ST rivets above the specified heat-treating range should be carefully avoided because of the danger of quench cracking and grain-boundary melting. Use of temperatures above the specified range also increases the tendency for shear cracks and, if carried far enough, will decrease the shear strength of the driven rivets as shown in Fig. 5.

The foregoing emphasizes the importance of having all reheat-treating of 24ST rivets (usually performed at the plant of the user) done at temperatures within the specified heat-treating range, 910 deg. to 930 deg. F. Reheat-treating within this temperature range will assure normal strengths, normal resistance to cracking, normal resistance to corrosion, freedom from quench cracking, and freedom from grain-boundary melting.

Table II and Fig. 4 show that the reduction of diameter of driven head from 0.375 in. to 0.333 in. is beneficial in reducing head cracks. Here again, however, it is shown in Fig. 5 that the use of the smaller diameter of driven head slightly reduces the shear strength of the rivet.

It should be emphasized that only one lot of commercial rivets is represented in this specific investigation. Some lot-to-lot variation, both as to cracking tendencies and shear strengths, is to be expected. Furthermore, the results on beginning of head cracking (such as seen in Fig. 4) do not represent precise determinations even on one lot of rivets. Much scatter is encountered in the actual test results, and the smooth curves are really only approximate indications of the trends observed.

It has already been pointed out that decreasing the diameter of driven head on a rivet is beneficial in decreasing head cracking but that it may also reduce the shear strength of the driven rivet. Therefore, caution should be exercised in applying this method of curing cracks. Tests made here were to supply some information on how far it is safe to go in reducing head sizes.

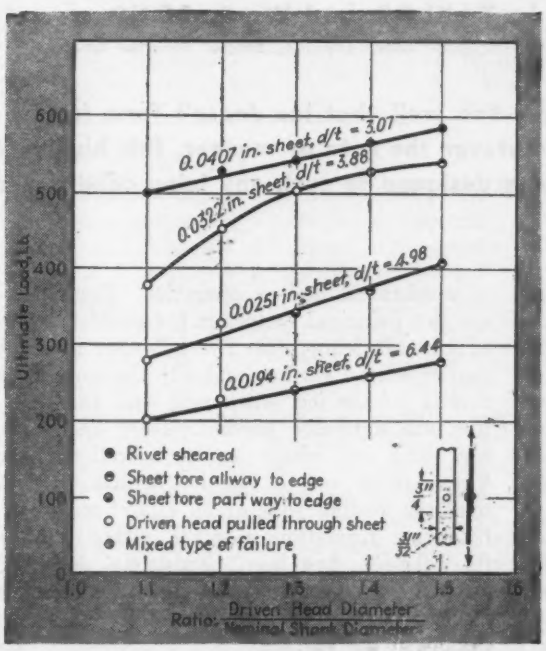


Fig. 7. Effect of size of driven head on strength of joint. Flathead 24ST rivets, .125 dia. in .1285 dia. holes; sheet of 24ST Alclad.

The tests were made on $\frac{1}{8}$ in. button-head 24ST rivets squeeze driven in joints of the type shown in Fig. 7. Single riveted lap joints in thin sheet were adopted to give maximum opportunity for failures by pulling the rivet head through the hole in the sheet. Shear strength of the undriven rivets, as determined in steel double-shear tools, averaged 39,200 psi., and the average tensile properties of the four thicknesses of 24ST Alclad sheet in the longitudinal direction (direction in which the sheet was used in the joints) were:

Tensile St.	66,900 psi.
Yield St. (Offset = 0.2 percent)	50,700 psi.
Elongation in 2 in..	18 percent

All rivet holes were 0.1285-in. dia.

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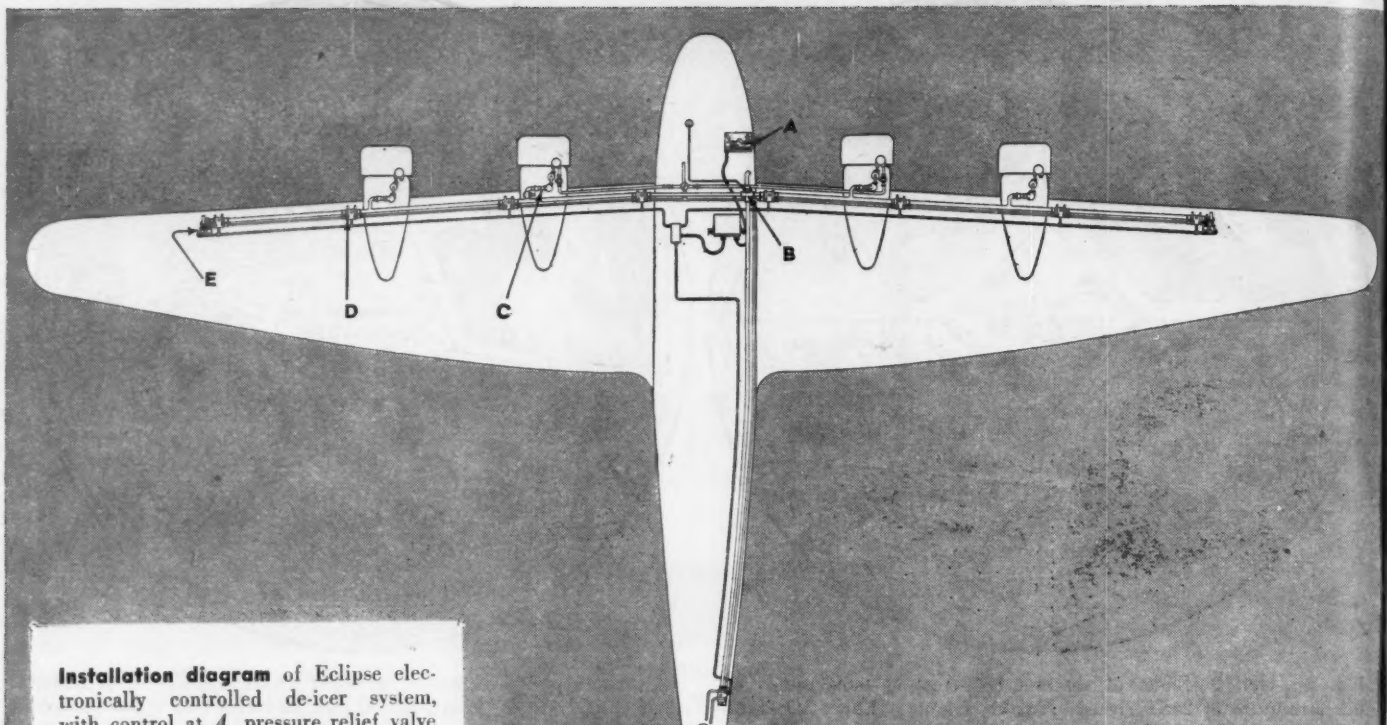


Installation diagram of Eclipse electronically controlled de-icer system, with control at *A*, pressure relief valve at *B*, oil separator and air filter *C*, electronically controlled solenoid-actuated distributor valve *D*, and electrically controlled unloading valve *E*.

Manifold-Solenoid De-Icer Systems With Electronic Control

By **M. L. TAYLOR and W. B. POND,** *Research Engineers, Eclipse-Pioneer Division, Bendix Aviation Corp.*

Pilots know only too well that ice doesn't form in any standardized fashion. But whatever the rate or manner, this highly flexible de-icer control system is designed to curb any icing condition encountered.

DE-ICER EQUIPMENT as currently used on aircraft provides a constantly recurring cycle of inflation and deflation of tubes along the leading edges of the protected airfoils and no control of the frequency or adjustment for completeness of inflation cycles is provided.

Unfortunately, however, nature does not supply ice at a standard rate or to a standard texture. In recognition of this condition, the Eclipse electronic de-icer control (Fig. 1) has been developed to control the operation of de-icers to suit the icing condition encountered.

In order to clarify the utility of the electronic de-icer control it might be well to review some of the fundamentals of mechanical de-icer operation. There are two principal factors in the problem of aircraft icing: (1) The adhesion of the ice to the surface and (2) the continuity of the ice. Although both factors are normally present, either factor alone will retain an ice accretion. The natural lock of an ice formation over the leading edge of an airfoil will hold that formation in place, although its adhesion has been completely destroyed. Similarly, isolated particles of ice can be retained solely by their adhesion to the surface.

Fundamentally, de-icer operation is based on playing the factors of continuity and adhesion against each other. It is because the ice is adhered to the de-icer surface that the inflation of the tube elements breaks the continuity of the ice along the leading edge. Also, it is only as the ice has continuity and enough tensile strength to maintain that continuity that the stretch of the rubber produces a peeling action which destroys the adhesion and lets the air stream carry the ice away.

Years ago aircraft operators learned that de-icers give better ice removal if at least an eighth of an inch of ice is allowed to accumulate before they are inflated. This is because the ice must build to a definite thickness in order to develop enough tensile strength to over-

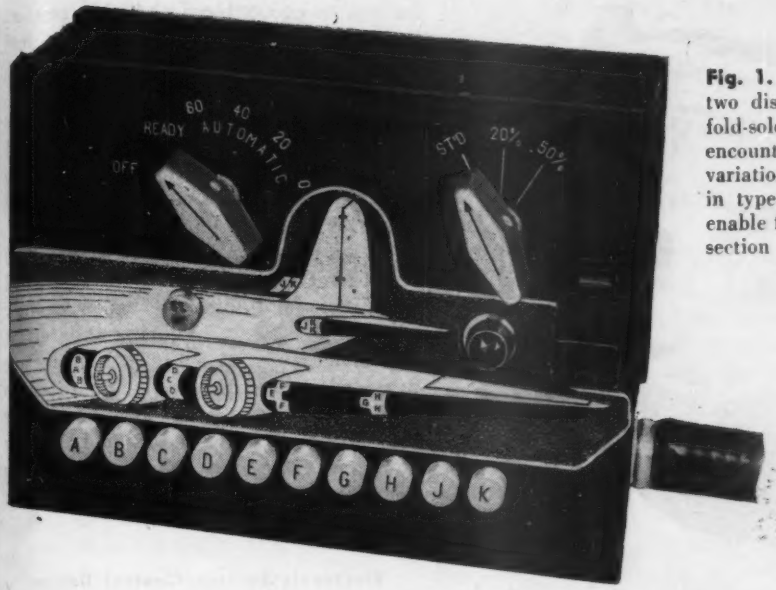


Fig. 1. Eclipse electronic de-icer control provides two distinct controls which permit operation of manifold-solenoid de-icer system to suit any icing condition encountered. One control provides adjustment to meet variations in rate of icing and one to care for variations in types of ice encountered. Illuminated push buttons enable flight crew to tell at a glance what specific de-icer section is in operation.

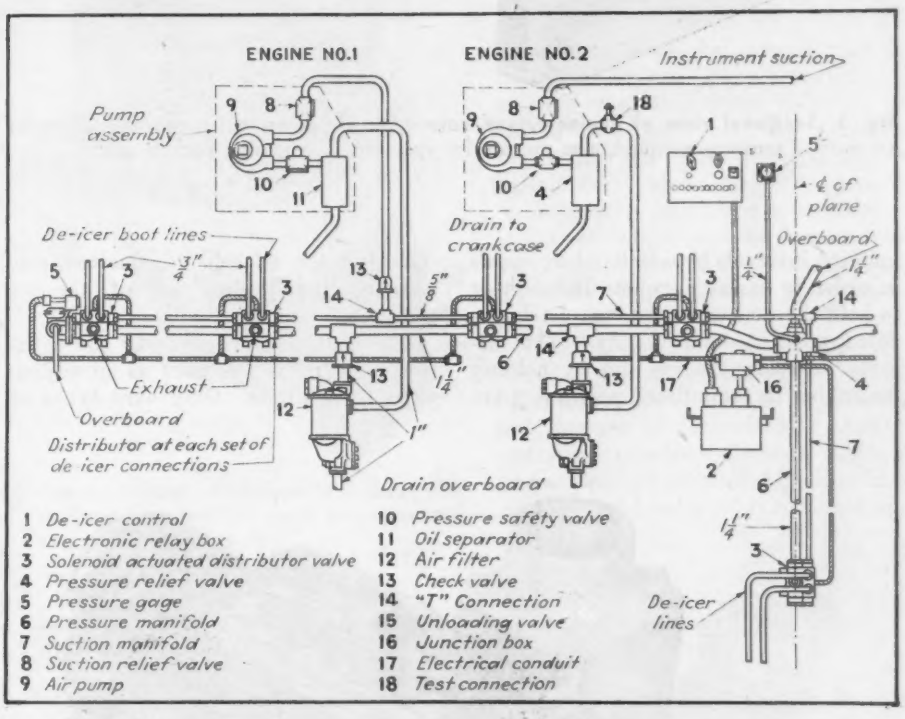
Fig. 2. Installation diagram of typical Eclipse manifold-solenoid de-icer system, which provides clean, light-weight, efficient system, with pressure line losses negligible because of single span-wise manifolds.

come adhesion. If the de-icers are operated with insufficient ice accumulated on them, the stretch of the rubber crazes the thin layer of ice, breaking it into many very small pieces, some of which are dislodged but most of which remain. Then further accumulation of ice builds on the little particles which remain, thus developing a flexible ice which is really composed of a number of separate little islands.

Once such a condition has been established the continuing cycles of inflation are relatively ineffective because the stretch of the rubber localizes in areas between islands without disturbing them.

Although operators have learned to allow a build-up of ice to accumulate before putting the de-icer system into operation, there has heretofore been nothing they could do about the recurring cycles which automatically followed in sequence at intervals of approximately 40 sec. If the rate of ice accretion was only moderate, the amount of ice built up between the first and second cycle was inadequate to afford good removal. Not only would such premature inflation remove little ice but worse, by crazing the ice it would ruin the possibilities of good ice removal thereafter. The need for a flexible control of de-icer recycling is apparent.

The Eclipse electronic de-icer control has been developed for use with the manifold-solenoid de-icer system—a system which replaces the central distributor and multiple tubing lines with pressure and suction manifolds and solenoid controlled distributing valves located at the individual de-icer boot connections. This method not only simplifies the plumbing installation and improves the rate of inflation and deflation of the de-icer boots, but it also reduces the control of inflations to an electrical circuit operating the solenoids. Thus a flexible control system is reduced to an electric timer mechanism.



Features of Electronic Control

The two principle features of the new electronic control are the control to suit variations in rate of icing and the control to suit variations in the type of ice encountered. In light ice conditions, the unit may be set for single cycle operation and the cycle called by punching a starting button whenever the ice has built up to a thickness sufficient for good removal. If the icing condition is moderately severe the unit may be set for automatic operation with a variable time delay between cycles depending upon the severity of the ice conditions. Finally, in severe ice the unit is set for automatic continuous operation with no delay between cycles.

For most icing conditions, and particularly for slushy ice, the rapidity of inflation is very important. With the older types of de-icer operating systems the inflation of the boots was sluggish and as a result the ice had time to mold itself to the changing contour of the de-icer surface. With the manifold-solenoid system the pressure manifold acts as a reservoir, and when a given solenoid is energized a poppet type valve opens and releases a surge of pressure directly into the de-icer boot cells which immediately punch out to a full inflation. This type of operation is maintained without change throughout the variations of cycling time previously described, as it is the desired operation for most icing conditions regardless of the rate of icing.

For very hard types of ice, however, the completeness of the inflation and resulting distortion of the rubber surface become more important than the rapidity of change. Accordingly, another control is provided which increases the

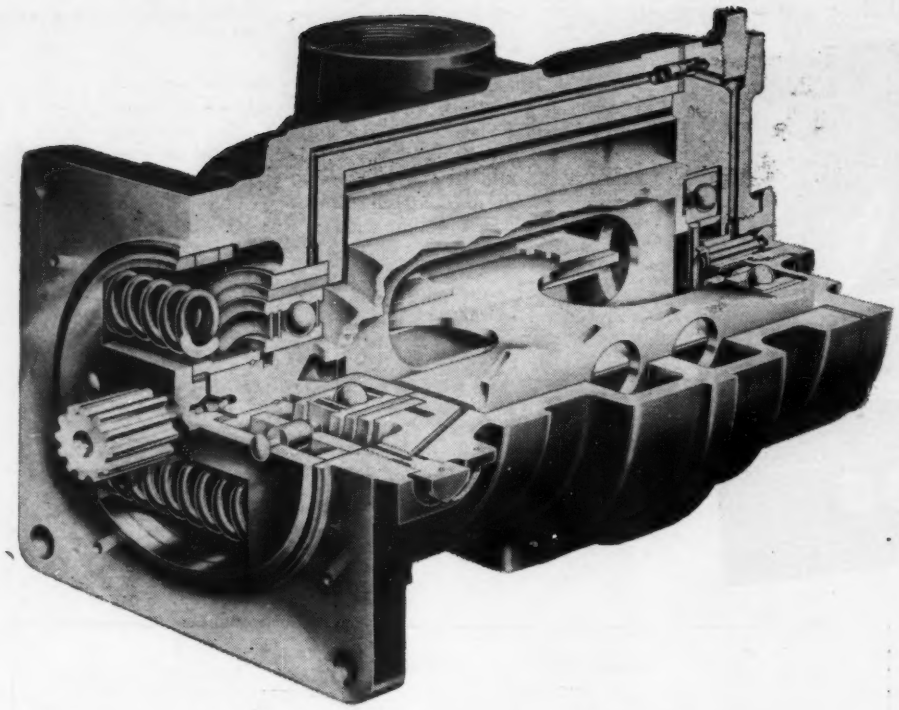


Fig. 3. Sectional view of engine-driven vane-type air pump which provides air under pressure to pressure manifold, also vacuum for operation of avigating instruments.

inflation intervals by selective increments in order to assure complete inflation or to hold the de-icer in the completely inflated position momentarily. This assures breaking the ice and by holding the rubber in the inflated position, gives time for the stretch to equalize, also assuring the peeling off of the ice particles.

The control for increasing the inflation intervals is also used as an adjustment for altitude. Only hard types of ice can be encountered at high altitudes, hence the rapidity of inflation is of less significance than at lower altitudes. Therefore, the control to provide longer inflation intervals may be utilized to compensate for the reduced output of the air pumps at high altitudes in lieu of supplying additional or auxiliary pumps for such conditions.

In addition to the foregoing control features, the control panel is equipped with indicator lights which show exactly what de-icer tubes are being inflated at any given time. Also, push buttons are provided which enable the operator to inflate any group or groups of de-icer cells desired. Such operation is purely a manual over-ride and the automatic operation is immediately restored after such interruption.

Fig. 4. Solenoid-actuated distributor valves, located at each set of de-icer connections, distribute air under pressure to de-icer cells. These valves have been designed to shut off individual de-icer.

Electronic De-Icer Control Design

The Eclipse electronic timer consists basically of a single Type 2050 thyratron tube, a condenser and resistor combination for controlling its firing time, a Strowger type step relay for switching the solenoid loads and the associated relays and switches necessary for interlocking and operating the circuit. The 2050 type of thyratron is of the hot cathode variety, and it has very stable characteristics as regards its firing voltage and can be depended upon to repeat performance accurately when used as a time delay control. Circuit for controlling the firing time of the tube is of the customary condenser resistor series combination in which the condenser is charged for each tube operation and so connected on the control grid and cathode that the grid is negative and prevents the tube from firing.

Charge on the condenser gradually leaks off over the series resistor until the grid potential has reached the firing point at which time the tube fires, completing a circuit to its plate relay and in this manner operating the timer. The various time intervals required are obtained by switching different resistors into the series condenser circuit for each timer step. In this manner is governed the time each wing solenoid is energized. A second relay, operated by the plate relay, makes and breaks the inductive solenoid load circuit and also operates the Strowger step relay which moves its contact arm and thus selects the consecutive solenoid circuits.

Provided with the Strowger relay are two banks of insulated contacts, one of which is used to switch the solenoid loads and the other to switch the timing resistors in the tube circuit. Thus it not only selects the next solenoid as it steps one position but also selects the time interval that this same solenoid will remain energized. After completing ten steps, the Strowger relay calls its own restoration control re-

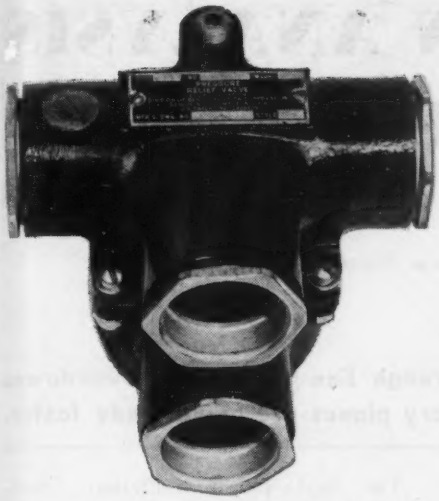


Fig. 5. Pressure relief valve limits pressure in de-icer system to 8 psi.

lay and restores to the zero position, ready for a second complete cycle of operations.

A repeat cycle will not occur until the start button is depressed, as long as the cycle control switch is set in the "single cycle" position. When the cycle control switch is advanced to the "automatic" position the next cycle will take place immediately, unless a delay between cycles has been set up. This is controlled by a six-position switch provided to introduce one of six resistance values in the timer circuit when the Strowger relay is in the home position. These resistance values have been arbitrarily set to give a variable time delay from 60 to 0 sec. between cycles.

To increase the length of impulse to the individual solenoids, a gang-switch is provided which calls in two completely different sets of timing control resistors, depending upon whether it is set for a 20 or 50 percent increase.

Manual control of the solenoids is provided for by a set of ten push button contacts that connect the solenoids directly across the 24 v. line. The contacts are active at any time, so it is possible to interrupt any cycle that is taking place and operate an individual solenoid, in which case the automatic cycle stops and resumes only after the manual push button has been released, at which time it will pick up operation at the point where the cycle was interrupted.

Provision has been made for operating the timer circuit directly on a 24 v. line, which would give insufficient plate voltage for the thyratron if it were not for the fact that an energy condenser is used to double the voltage momentarily and thus give a high enough level at firing times to maintain stable operation. The energy condenser is charged each time the tube fires and is placed in series with the line on the plate of the tube ready for the next operation.

Manifold-Solenoid De-Icer System

The manifold-solenoid de-icer system (Fig. 2) consists essentially of air pumps, a single span-wise suction and pressure manifold, solenoid actuated distributor valves, pressure type oil separator and air filters, pressure relief valves, and unloading valves. Distribution of air under pressure, provided by engine driven vane type air pumps (Fig. 3) to the de-icer cells is accomplished by energizing the solenoid actuated distributor valves (Fig. 4) located at each set of de-icer connections.

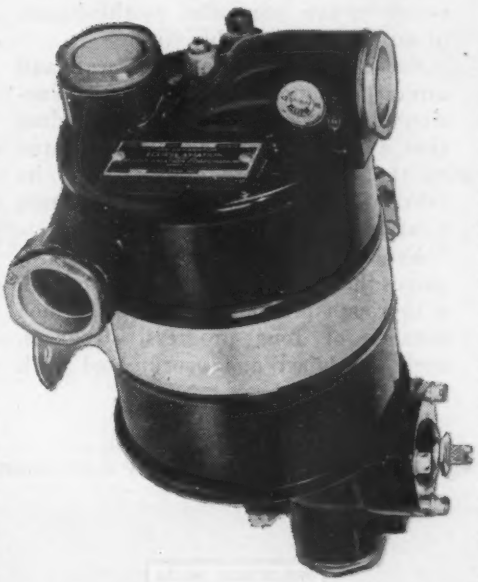


Fig. 6. Eclipse oil separator and air filter designed to remove oil vapor from manifold-solenoid de-icer system.

These valves have been designed for straight-through manifold connections, and they serve as the main support of the manifold lines. The de-icer connection ports are marked *A* and *B* to correspond to the markings of the terminals in the electrical disconnect plug and are in reality two identical valve units in one body having a common exhaust port which normally dumps into the wing cavity but which is provided with a compression fitting in case it is necessary to connect the discharge overboard. The check valve spring on the discharge is designed to close at 1 in. Hg. differential.

Under normal de-icer tension, this means that the inflation cells of the de-icer will deflate 95 percent of their inflated capacity overboard. The residual 5 percent of air is then pulled out and the cells are held under suction by a connection to the suction manifold. These valves have been designed to close—i.e., shut off—the individual de-icer in the event of failure of either the electric or pressure system. This has been done as a safeguard against any possibility of landing with any de-icer inflated. The solenoid operates a small pilot valve which reverses pressure and suction on the opposite sides of a diaphragm, which in turn operates the main poppet valve which connects the de-icer to pressure or exhaust and suction.

Pressure in the system is maintained at 8 psi. by the pressure relief valve (Fig. 5); an oil separator and air filter (Fig. 6) is incorporated to remove air vapor and condensation from the system, and air check valves are used to prevent reverse flow of air.

Unload Valves Installed

In order to allow circulation of warm air from the pumps through the system and to unload the air pumps when the system is not being used, manifold unloading valves (Fig. 7) are installed at each outer end of the manifold. The valves have been designed for mounting on the end of the solenoid actuated distributor valves and are provided with double outlet port connections, either of which can be used. These valves are solenoid operated and automatically close whenever the system is put in operation.

The Eclipse electronic control with the Eclipse manifold-solenoid de-icer operating system affords a simplified but thoroughly dependable system for operating Goodrich de-icers efficiently and at their greatest effectiveness under all types and rates of icing conditions.

Fig. 7. Manifold unloading valves installed at each outer end of pressure manifold permits circulation of warm air through manifold-solenoid de-icer system and also unloads air pumps when system is not being used.

AIRCRAFT PRODUCTION ANALYSIS

Key to Assembly Line Efficiency

Part I

BY LOREN F. DORMAN, *Production Design Engineer, Curtiss-Wright Corp., Aircraft Div., Missouri.*

Complete detailing of 1943's thorough line-production breakdowns shows means by which more military planes are being made faster.

WITH THE ADVENT of large number contracts for the construction of military and commercial aircraft, it has become desirable to assemble aircraft and their components by a more efficient method than in the past.

To date, we consider the most efficient assembly procedure to be that known as progressive line assembly, progressing either constantly or periodically, after the manner of automotive continuous-line assembly.

Since an aircraft is a relatively complicated piece of machinery, it must undergo a thorough production analysis of design and manufacture, in order that its detail application to a continuous line assembly may be reduced to simple planning operations.

Purpose of this article is to show that such a production analysis will result in the successful establishment of an efficient assembly line.

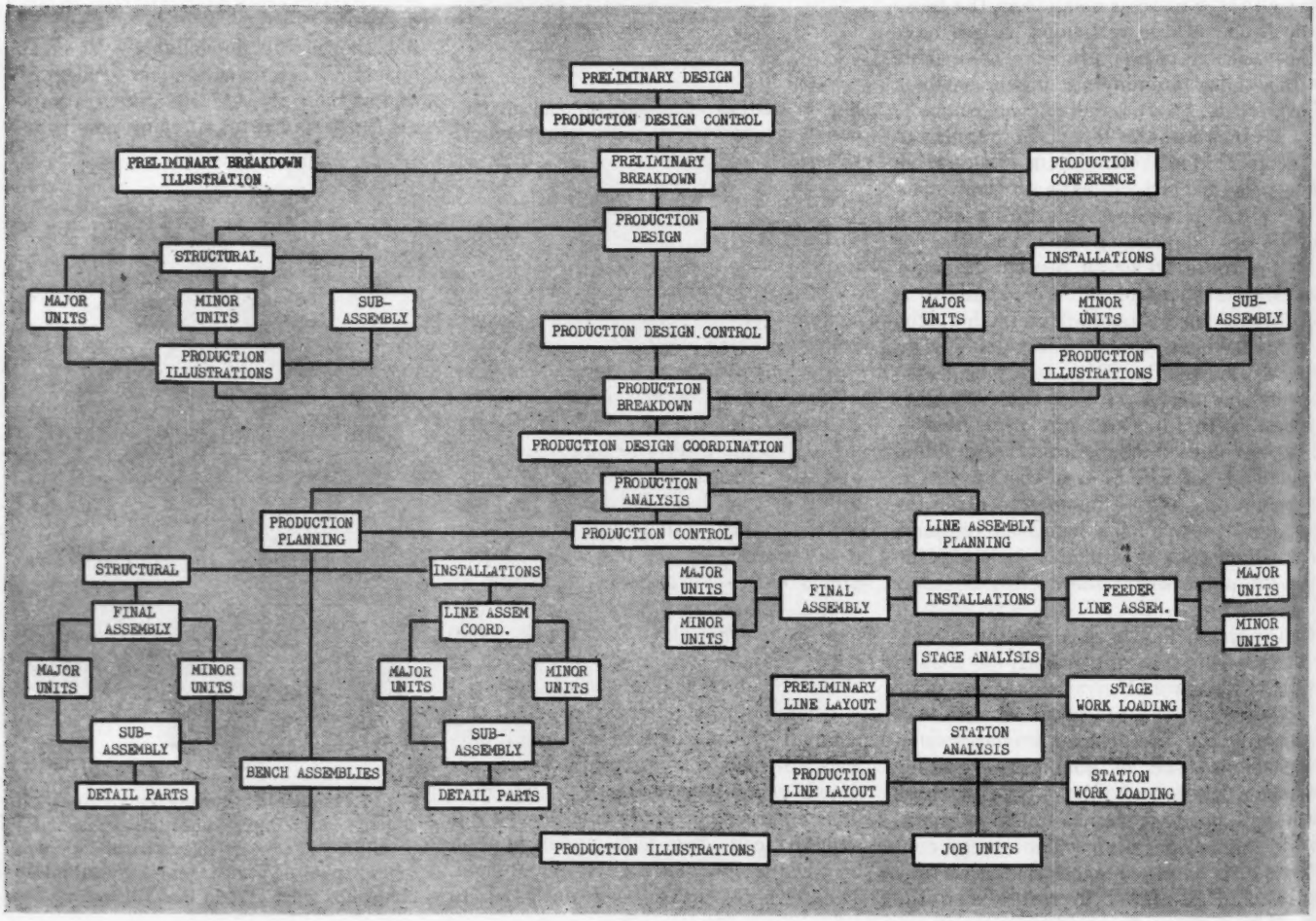
Successful production of aircraft and aircraft components by mass production line assembly methods requires that a flow of assemblies be operated so that a complete aircraft may be fabricated with maximum man-hours relative to minimum elapsed hours.

Establishment of such a system requires that the subject aircraft undergo a thorough production analysis, which consists of four progressive phases, each developed and coordinated with the others.

The first phase-production breakdown provides for a complete production analysis of the airplane during the design stage in order to establish suitable components for construction relative to those items which affect fabrication and assembly. Items for consideration are handling size, jigging, sequence of assembly, interchangeability, subassembly, etc.

Second phase provides for the production planning and line assembly planning of those items established in our first phase. Production planning essentially consists of major unit, minor unit, subassembly and planning, bench

Fig. 1. Procedure of line assembly development.



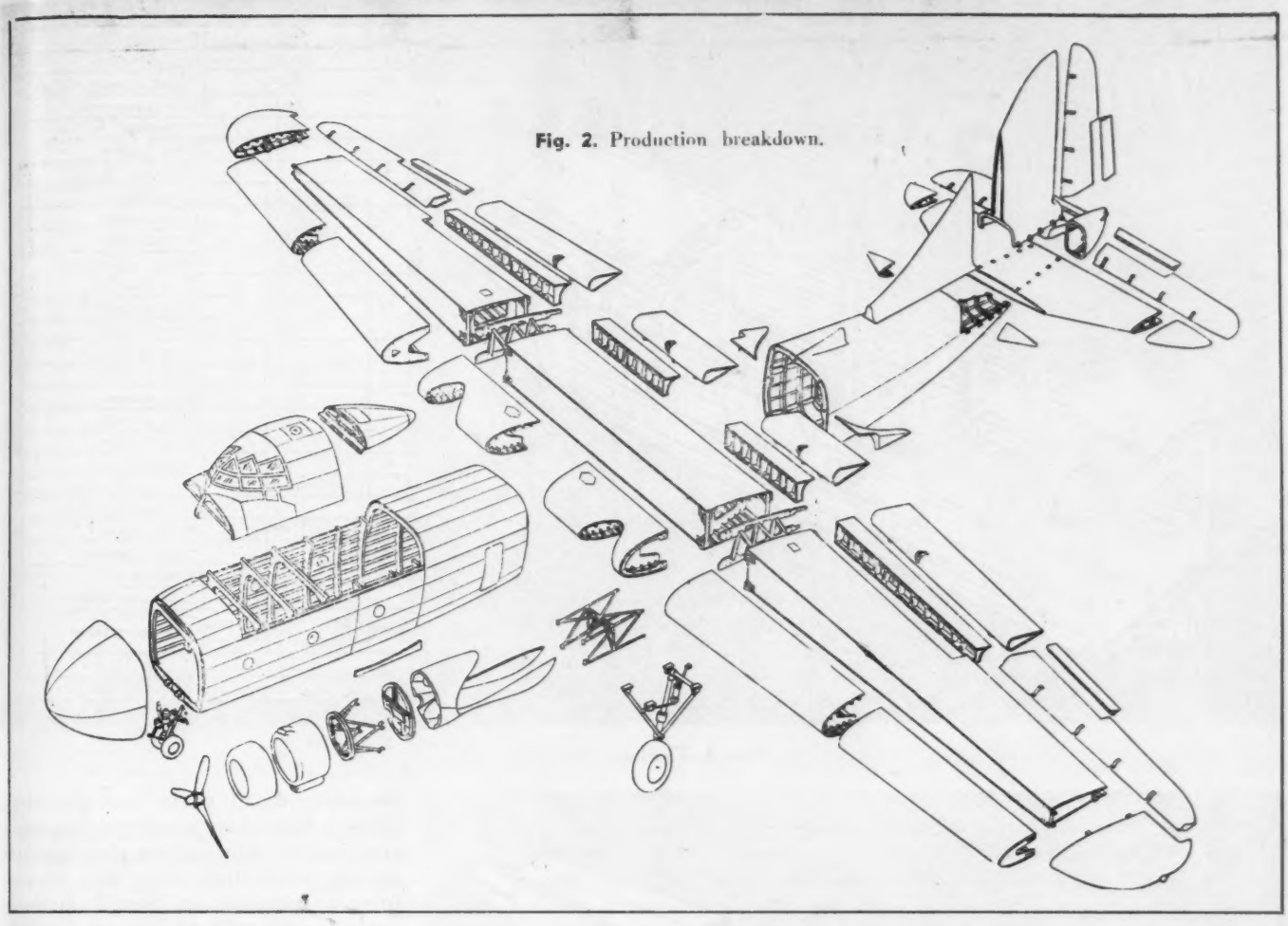


Fig. 2. Production breakdown.

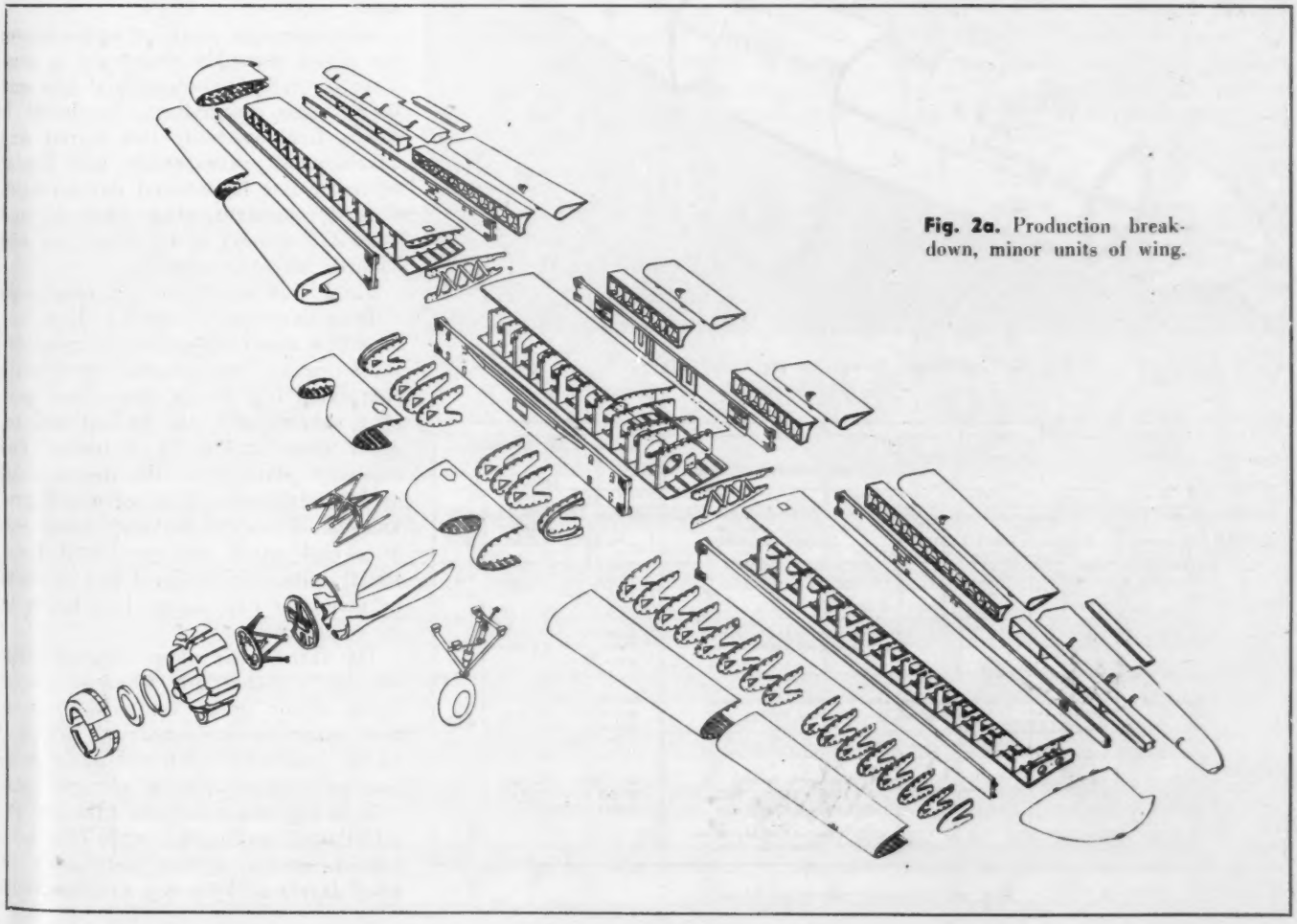
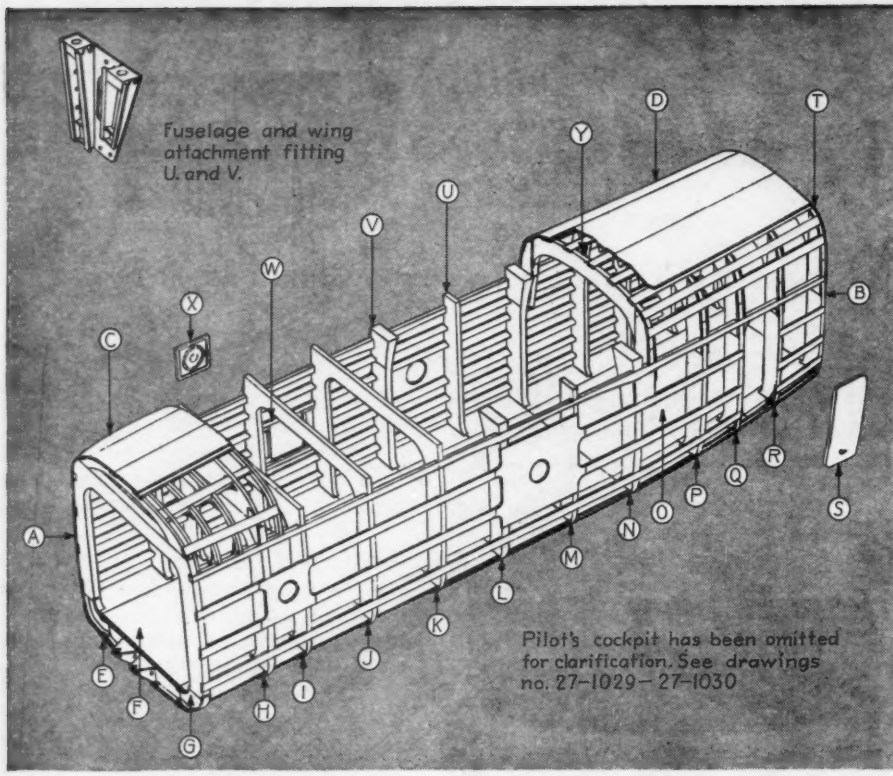


Fig. 2a. Production breakdown, minor units of wing.


Fuselage and wing attachment fitting U and V.
Pilot's cockpit has been omitted for clarification. See drawings no. 27-1029 – 27-1030

Code	Part number	No. req. per unit	Part name
Y	1163	1	Ring assem.
X	1466	1	Escape hatch
W	1486	1	Frame assem. hatch
V	1483	1	Fitting assem.
U	1483	1	Fitting assem.
T	1273	1	Ring assem.
S	1473	1	Door assem.
R	1068	1	Ring assem.
Q	1067	1	Ring assem.
P	27-210-1066	1	Ring assem.
O	27-260-1003	1	Ramp assem.
N	1065	1	Ring assem.
M	1064	1	Ring assem.
L	1063	1	Ring assem.
K	1062	1	Ring assem.
J	1062	1	Ring assem.
I	1062	1	Ring assem.
H	1061	1	Ring assem.
G	27-210-1060	1	Ring assem.
F	27-260-1002	1	Floor assem.
E	27-380-1016	1	Nose gear supp.
D	1152	1	Shell assem. A.D.
C	1142	1	Shell assem. F.D.
B	1010	1	Frame assem.
A	1004	1	Shell assem.
	27-210-1000		Fuselage assem.

FUSELAGE ASSEMBLY
Next assembly (27-800-1000)

Fig. 3. Fuselage Assembly.

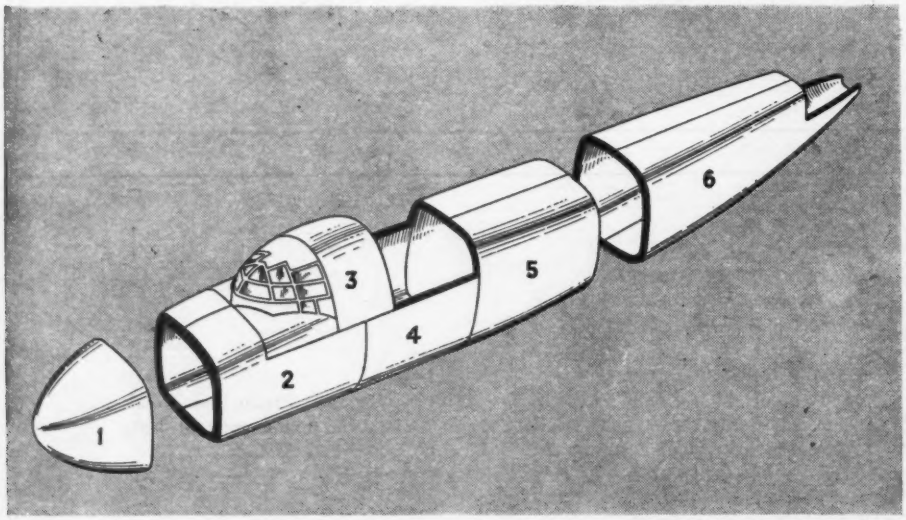


Fig. 5. Zone chart (zones are right and left).

Planner: R. Schmdt | Revised: R.S. | Date: 10/14/42 | JOB UNIT OPERATION SHEET | Job Unit Number: 429-4402
Checked: B. E. Jones
Approved: R. A. Foster | Production Illustration No. 2071 | Model | Unit | Station | Zone

Operation	Part Number	Part Name	Quantity	Prod. Control	Assembly Procedure	Tools Required	Elapsed Time	Time Stud.
1	S84-46-422-9	Pad	2		Attach pads to brackets -	Crescent Wrench	8 min.	
	AN515-8-24	Screws	4		Oil tank lower surface.	Screw Driver		O.K.
	AN960-8	Washers	8					C.M.
	NAF1137-832	Nuts	4					
2	S84-46-422-13	Pad	2		Attach pads to brackets -	Crescent Wrench	8 min.	
	AN515-8-24	Screws	4		oil tank upper surface.	Screw Driver		O.K.
	AN960-8	Washers	8					C.M.
	NAF1137-832	Nuts	4					
3	S84-46-520	Strap Assem.	2	Shortage	Attach straps to brackets -	Crescent Wrench	6 min.	
	AN24-26	Bolts	2	10-16-42	oil tank upper surface	Pliers		O.K.
	AN960-416	Washers	2			Screw Driver		C.M.
	AN320-4	Nuts	2					
	AN380-C2-2	Cotters	2					
4	63701	Fuel Strainer	1		Bolt strainer to casting -	1/2" Brush	10 min.	
	AN4-43	Bolts	2		lower surface of fuel tank.	1" Hex Head		
	AN960-416	Washers	2		(Apply sealing compound).	Socket Wrench		
	NAF1137-428	Nuts	2					
	AN684-17D	Elbow 45°	1		Apply threadlube to elbows and			
	AN842-17D	Elbow 90°	1		screw in strainer as shown.			

Fig. 6. Job unit operation sheet.

assembly, detail parts and planning, parts and assembly priorities, operation analysis and routing, tool planning and control, production order and release, project coordination, detail methods analysis, and unit flow chart development.

Line assembly planning encompasses the entire assembly system of a complete aircraft, including final line and feeder line assemblies. In detail it covers final assembly line layout and development, subassembly and feeder assembly line layout and development, shop development, stage analysis, and the establishment of handling jigs and fixtures for final assembly.

Final line assembly planning consists of development on the shop floor of a line assembly system to assemble those major components previously fabricated, to install items not part of a subassembly, and to test and inspect installations. And feeder line assembly planning is the development of tributary assembly lines which provide bench assemblies and subassemblies and minor structural and functional units, with a timed flow of units achieved for final assembly relative to its requirements.

The third basic phase is production control, a procedure whereby major units, minor units, component parts, and installations are ordered, accounted for, handled, stored, and issued relative to assembly system requirements.

It is important to note that the establishment and maintenance of a production control system *determines to what degree of efficiency* a successfully

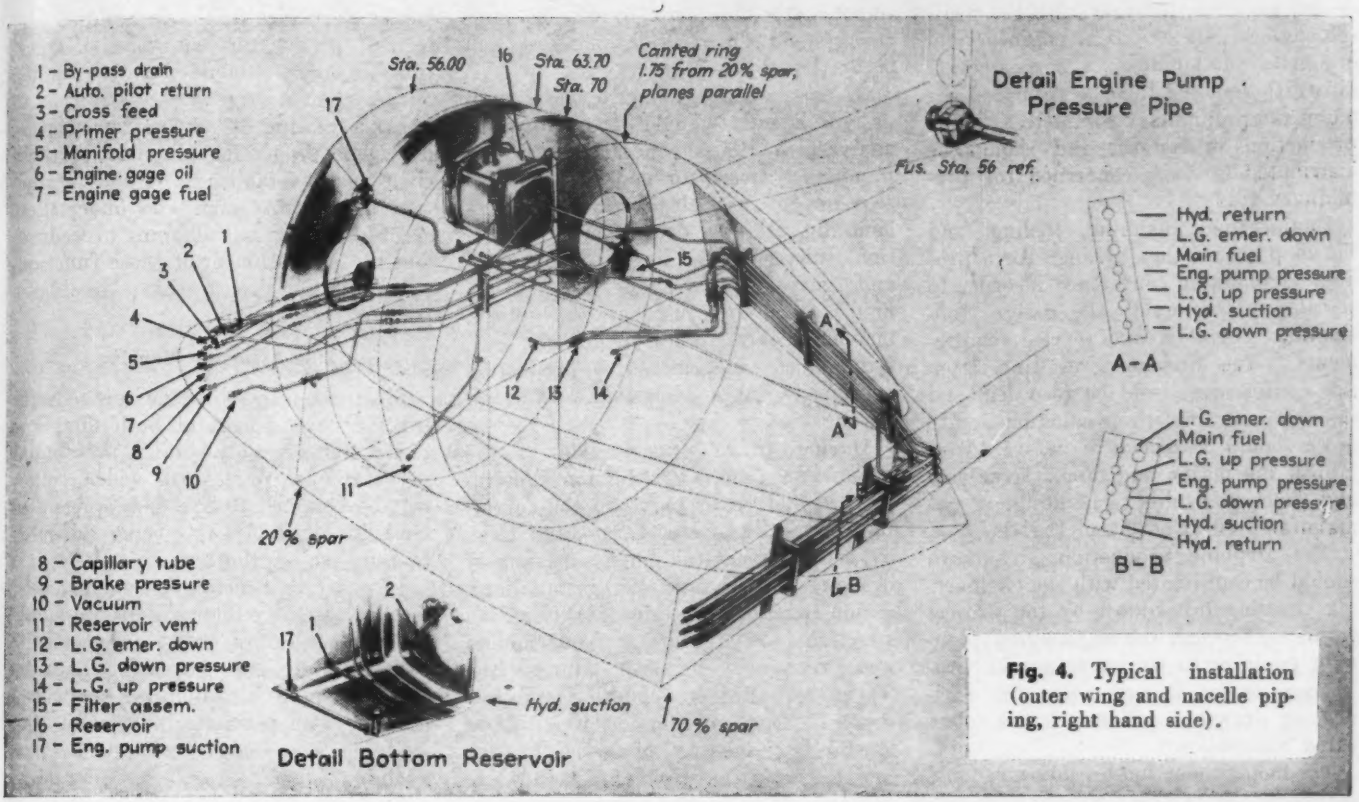


Fig. 4. Typical installation (outer wing and nacelle piping, right hand side).

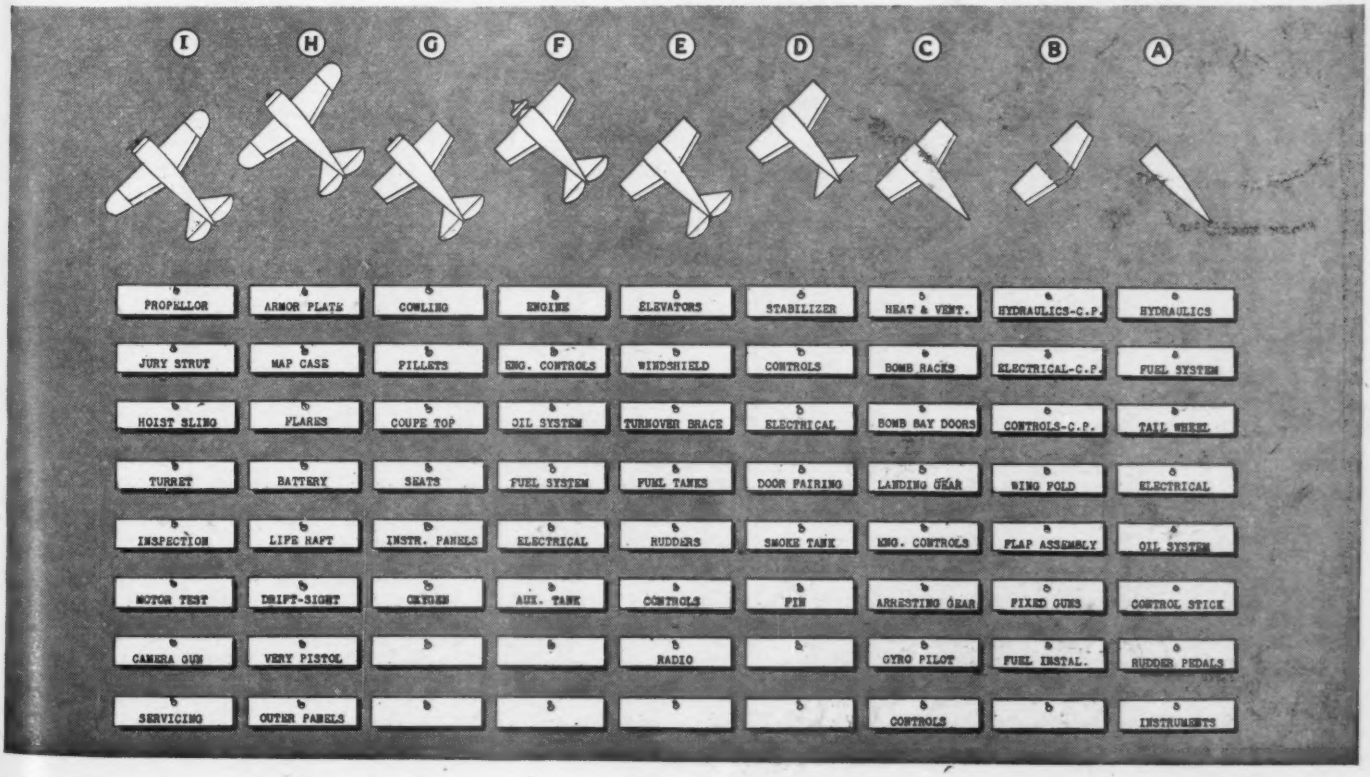
developed assembly line will operate.

Fourth and final phase is the use of production illustrations, a clear, concise system for the conveyance of detailed production information based on the use of perspective drawings. These illustrations, made concurrently with the design and production stages, consolidate pertinent production information and eliminate blue prints, except as required by supervisory personnel.

It is required in the development of these phases that they be considered relative to the airplane design or production stages, such as preliminary design, production design, production planning, line assembly planning, fabrication and subassembly, and final assembly. In addition, the responsibility of each department or group, coordination procedures, and the preparation and distribution of production illustrations must be considered (Fig. 1).

During preliminary design, a major and minor unit production breakdown should be made in conjunction with structural, functional, and arrangement requirements. This breakdown should be done by the production

Fig. 7. Work loading chart.



design engineer, together with the project engineer, development engineer and design layout engineers. A production illustration should then be prepared defining the preliminary complete airplane production breakdown and should be distributed to those concerned for preliminary study.

Engineering, planning, tooling, and the shop should then arrange for a production planning conference in order to coordinate thoroughly the design, fabrication, assembly, and service requirements. The decisions resulting from this conference should be recorded, and the resultant airplane production breakdown should be issued, as before, to establish the major and minor structural and functional units to be designed and manufactured (Fig. 2 and Fig. 2a).

The airplane production breakdown should be coordinated with the engineering drawing breakdown by the project engineer, through the engineering planning engineer in conjunction with production design, in order that the engineering drawings will match the fabricated assemblies.

The final production breakdown should determine the major, minor, and subassembly unit design sections for both structure and installations. It should be the responsibility of production design engineering to coordinate any changes with production planning and obtain its approval.

As production design progresses, unit design layouts should frequently be analyzed by those concerned with the planning. Items for consideration are sequence of assembly, power riveting, handling, storage, detail parts fabrication, subassemblies, jigging, sheet sizes and gages, sub-assembly installation, final assembly installation, splices, matching parts, holes, tolerances, etc., spot-welded assemblies, production equipment, subcontract items, and processing.

During further progression of the production design, production illustrations should be prepared in the following order: Major structural units (Fig. 3), minor structural units, subassembly drawings, major functional installations, minor functional installations (Fig. 4), functional installations, subassemblies, and preliminary jigs and fixtures (Fig. 9) as requested by planning and tool design. These production illustrations should be issued to planning, tooling, and the shop in advance of, or in conjunction with, normal production drawings to facilitate production analysis.

As the design is released to planning for production fabrication, the production design group should check each detail, subassembly, and major assembly for conformance to the breakdown and current production requirements. Questionable items should be coordinated with planning.

Upon receipt of advance production drawings, production planning of those components established by the production breakdown should be undertaken, according to normal planning procedures and the establishment of those functional installation items which may be a part of subassembly.

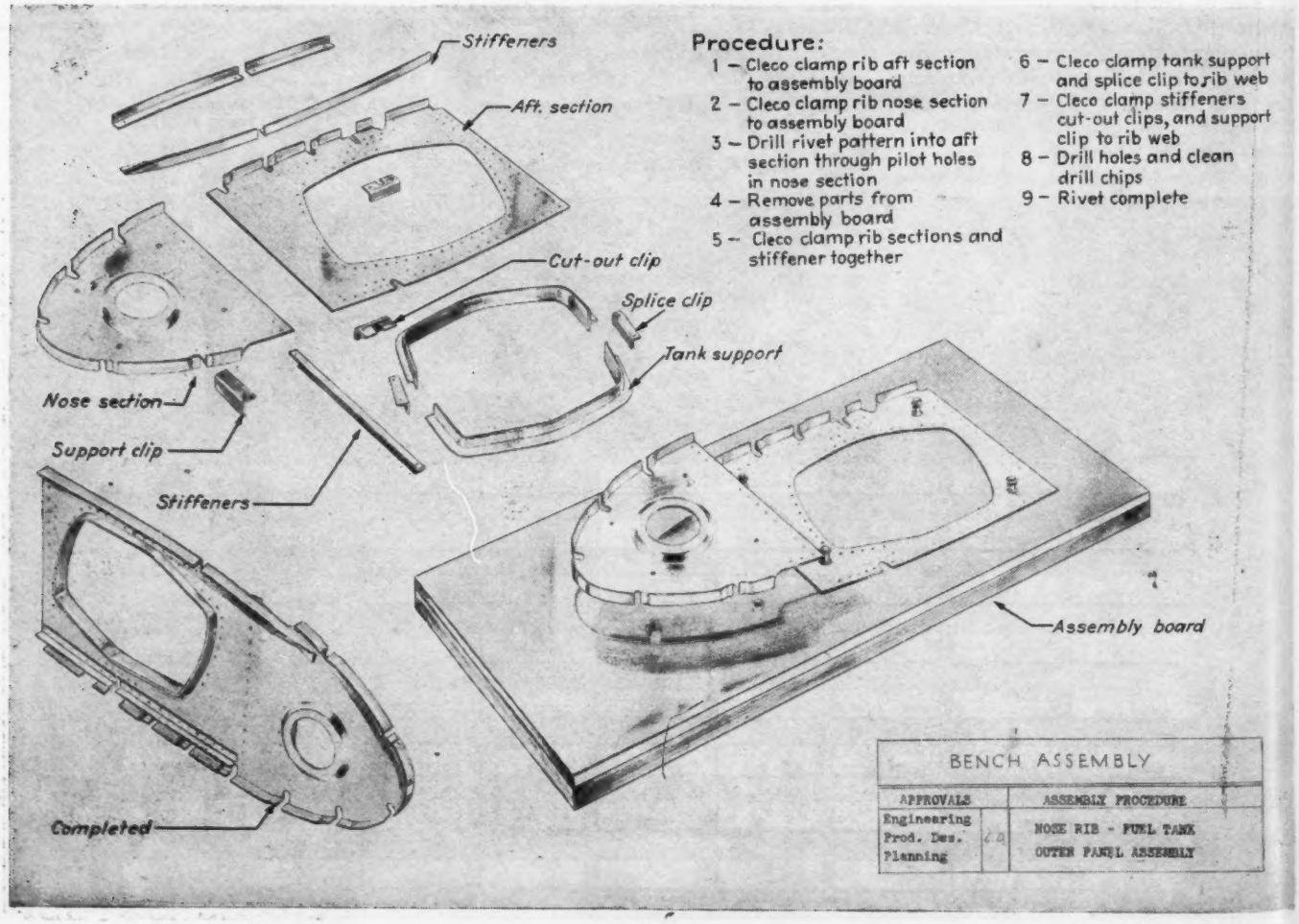
Line Assembly Planning

Since the basic procedures necessary for the development of both final and feeder line assembly systems are similar in detail, the procedures which follow will be confined to the development of final line assembly, this being the more complicated of the two types.

In order to function most efficiently, the line assembly planning group should be composed of a group of men with both planning and shop experience supervised by a coordinating supervisor familiar with planning, shop, and time study methods, conveyor systems, production control systems, and plant layout. A lead planner should be assigned to each unit installation, and should have as his immediate assistant the shop lead man assigned to cover a specific section of the final assembly line;

(*Turn to page* 332)

Fig. 8. Bench assembly.


Stiffeners
Aft. section
Cut-out clip
Splice clip
Tank support
Nose section
Support clip
Stiffeners
Completed
Assembly board
Procedure:
1 – Cleco clamp rib aft section to assembly board
2 – Cleco clamp rib nose section to assembly board
3 – Drill rivet pattern into aft section through pilot holes in nose section
4 – Remove parts from assembly board
5 – Cleco clamp rib sections and stiffener together
6 – Cleco clamp tank support and splice clip to rib web
7 – Cleco clamp stiffeners cut-out clips, and support clip to rib web
8 – Drill holes and clean drill chips
9 – Rivet complete
BENCH ASSEMBLY
APPROVALS
Engineering
Prod. Des.
Planning
ASSEMBLY PROCEDURE
NOSE RIB - FUEL TANK OUTER PANEL ASSEMBLY

Analysis of Members With Variable Moments of Inertia

By YVES NUBAR, *York Research Corp.*

Presenting in concise and ready form essential data and characteristics for analyzing members with varying moments of inertia, including general expressions for slope deflection equations, fixed end moments, stiffness and carry-over factors, and three moment equations.

As a result of increasingly complex requirements in the design of structural frameworks—in aircraft construction as well as in many branches of civil engineering—the analysis of rigid structures has become an everyday necessity. For structures in which the members have constant moments of inertia along their length, a number of methods of frame analysis are available, well developed and of straightforward application.

Among them, the method of slope deflection, that of Hardy Cross, and the equations of three moments are probably in greatest use.

The problems of how to deal with the frequent case of members with varying moments of inertia is somewhat more complex and, for the average engineer, not adequately covered.

Although exact methods for the analysis of such cases are in existence (see, among others, the seven references given at the conclusion of this article) they are widely scattered in the technical literature. Many of them, in the opinion of the writer, are somewhat limited in extent and in scope.

As a service to the industry, then, this article derives and presents in ready form all essential data and characteristics for the analysis of members with moments of inertia varying arbitrarily, including the general expression for the slope deflection equations, fixed-end moments, stiffness and carry-over factors, three moment equations, etc.

The engineer who is familiar with the application of some of the above-mentioned methods to rigid frames with members of uniform size will make use of these general data in an identical fashion, whether he favors the method of slope deflections, or that of Hardy Cross, or the theorem of three moments.

Analysis of a twin-boom system for a large airplane will be outlined here as as illustration. Symbols are defined when first used, and in addition they are tabulated in the accompanying box for handy reference.

In Fig. 1, line 1–2 represents the original position of a member in a rigid

Symbols

l	span.
E	modulus of elasticity.
I	moment of inertia.
k	I/l.
y_1 , y_2	transverse displacements of of ends 1 and 2.
ω_1 , ω_2	rotations at ends 1 and 2.
R	$(y_2 - y_1)/l$.
M	bending moment.
m	bending moment, when member is on simple supports.
M_{12} , M_{21}	moments exerted by joints 1 and 2 upon member 1–2.
m_{12} , m_{21}	fixed-end moments exerted by joints 1 and 2 upon member 1–2.
M_1, M_2, M_3	moments over supports in continuous beams.
H	transverse shear.
A, B, C	areas of diagrams, as shown in Figs. 2, 3, and 4.
a, b, c	ratios locating centers of gravity of these areas.
S_{12}, S_{21}	stiffness at ends 1 and 2 of members 1–2.
c_{12}, c_{21}	carry-over factors at ends 1 and 2 of member 1–2.

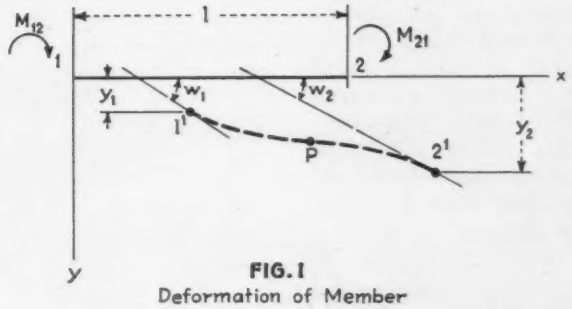


FIG. 1
Deformation of Member

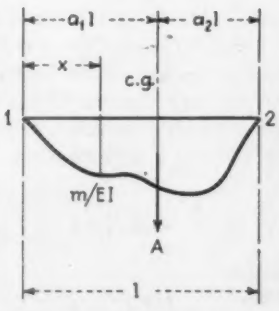


FIG. 2
m/EI Diagram

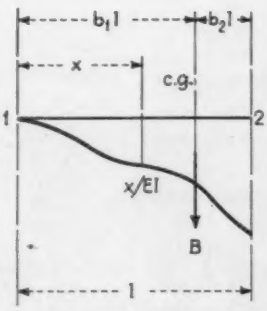


FIG. 3
x/EI Diagram

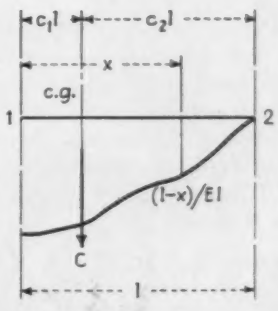


FIG. 4
(l–x)/EI Diagram

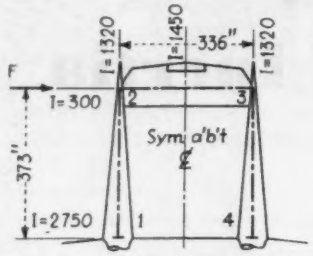


FIG. 5
Plan of Twin Boom System

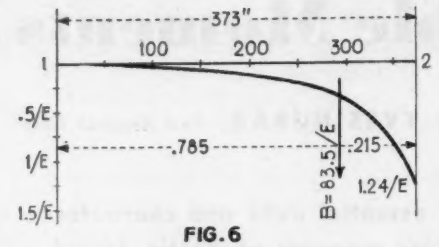


FIG. 6
x/EI Diagram

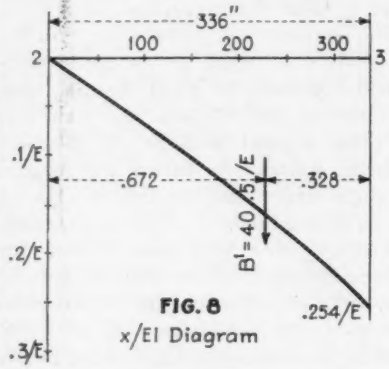


FIG. 8
x/EI Diagram

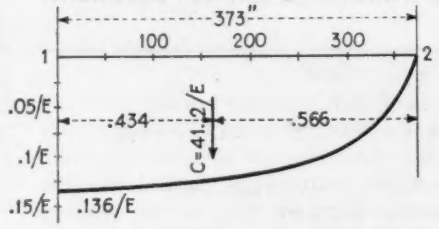


FIG. 7
(2-x)/EI Diagram

frame; 1′–2′ its position after deformation and displacement. Joints 1 and 2 have moved transversely distances y_1 and y_2, the end tangents have rotated through angles ω_1 and ω_2. Member 1–2 is loaded in any arbitrary fashion (loading not shown). Moments are exerted upon the member by the adjoining parts of the frame; they are denoted by M_{12} and M_{21}, applied respectively at joints 1 and 2. All rotations and moments are considered positive in a clockwise direction.

With coordinate axes as adopted in Fig. 1, the basic equation relating displacements to applied loads is

$$\frac{d^2y}{dx^2} = -\frac{M}{EI} \qquad (1)$$

in which, x and y are the coordinates of any point P on the member, M is the bending moment, I the moment of inertia, and E the modulus of elasticity, all referred to point P (therefore variable along the span, in the general case). The derivation of this formula, together with the underlying assumptions, may be found in any textbook on mechanics; it will be expressly assumed here that the axial deformations in the member are negligible, as is usually the case, and that elastic instability phenomena may be disregarded.

It is known that M may be expressed as follows

$$M = +m - M_{21}\frac{x}{l} + M_{12}\left(1 - \frac{x}{l}\right) \qquad (2)$$

in which m represents the bending moment which would exist at point P if the ends of the member were free to rotate.

Substituting (2) into (1)

$$\frac{d^2y}{dx^2} = \frac{1}{EI}\left[-m + M_{21}\frac{x}{l} - M_{12}\left(1 - \frac{x}{l}\right)\right] \qquad (3)$$

Integrate equation (3)

$$\frac{dy}{dx} = -\int_o^x \frac{m}{EI}\,dx + \frac{M_{21}}{l}\int_o^x \frac{x}{EI}\,dx - \frac{M_{12}}{l}\times \int_o^x \frac{(l-x)}{EI}\,dx + \omega_1 \qquad (4)$$

This expression satisfies the left boundary condition that for $x = 0$, dy/dx should equal ω_1; the corresponding boundary condition at the right end requires that $dy/dx = \omega_2$ for $x = l$, or

$$\omega_2 = -\int_o^l \frac{m}{EI}\,dx + \frac{M_{21}}{l}\int_o^l \frac{x}{EI}\,dx - \frac{M_{12}}{l}\times \int_o^l \frac{(l-x)}{EI}\,dx + \omega_1 \qquad (5)$$

The three integrals appearing in this relation have simple meanings:

$$\int_o^l \frac{m}{EI}\,dx$$

represents the area A between the x axis and a curve plotted to represent m/EI at each point along the span (Fig. 2); similarly,

$$\int_o^l \frac{x}{EI}\,dx \quad \text{and} \quad \int_o^l \frac{(l-x)}{EI}\,dx$$

are respectively areas B and C of diagrams x/EI (Fig. 3) and $(l-x)/EI$ (Fig. 4). These areas are shown located on the vertical of their centers of gravity. A is a dimensionless number, while B and C have $(\text{force})^{-1}$ as dimension.

Therefore:

$$\omega_2 = -A + M_{21}\frac{B}{l} - M_{12}\frac{C}{l} + \omega_1 \qquad (6)$$

Integrating (4)

$$y = -\int_o^x dx\int_o^x \frac{m}{EI}\,dx + \frac{M_{21}}{l}\int_o^x dx\int_o^x \frac{x}{EI}\,dx - \frac{M_{12}}{l}\int_o^x dx\int_o^x \frac{(l-x)}{EI}\,dx + \omega_1 x + y_1 \qquad (7)$$

This relation satisfies the left boundary requirement that y should equal y_1 for $x = 0$; it should also equal y_2 for $x = l$, or $y_2 =$

$$-\int_o^l dx\int_o^x \frac{m}{EI}\,dx + \frac{M_{21}}{l}\int_o^l dx\int_o^x \frac{x}{EI}\,dx - \frac{M_{12}}{l}\int_o^l dx\int_o^x \frac{(l-x)}{EI}\,dx + \omega_1 l + y_1 \qquad (8)$$

Considering the first integral in (8), it can be proved easily that

$$\int_o^l dx\int_o^x \frac{m}{EI}\,dx = \int_o^l \frac{m}{EI}(l-x)\,dx \qquad (9)$$

It is only necessary to remark that both members of (9), considered as functions of l, have identical derivatives with respect to l and that both assume the value 0 for $l = 0$.

Similar results obtain for the other integrals in (8)

Therefore, calling $y_2 - y_1$ the relative deflection of the member and designating it by Rl, equation (8), may be written $Rl =$

$$-\int_o^l \frac{m}{EI}(l-x)\,dx + \frac{M_{21}}{l}\int_o^l \frac{x(l-x)}{EI}\,dx - \frac{M_{12}}{l}\int_o^l \frac{(l-x)^2}{EI}\,dx + \omega_1 l \qquad (10)$$

From Fig. 2, it may be seen that

$$\int_o^l \frac{m}{EI}(l-x)\,dx$$

is the statical moment $A.a_2l$ of the area A with respect to end 2; similarly

$$\int_o^l \frac{x(l-x)}{EI}\,dx = B.b_2l \quad \text{and} \quad \int_o^l \frac{(lx)^2}{EI}\,dx = C.c_2l.$$

Using these expressions in (10), the following relation is obtained:

$$R = -A.a_2 + M_{21}\frac{B.b_2}{l} - M_{12}\frac{C.c_2}{l} + \omega_1 \qquad (11)$$

Incidentally, the useful equation

$$B.b_2 = C.c_1 \qquad (12)$$

may be written by simple inspection of Fig. 3 and 4.

M_{12} and M_{21} are now obtained by solving equations (6) and (11):

$$M_{12} = \frac{l}{C(c_2 - b_2)}(\omega_1 b_1 + \omega_2 b_2 - R) + \frac{A}{C}\,l\,\frac{b_2 - a_2}{c_2 - b_2}$$

$$M_{21} = \frac{}{B(c_2 - b_2)}(\omega_1 c_1 + \omega_2 c_2 - R) + \frac{A}{B}\,l\,\frac{c_2 - a_2}{c_2 - b_2} \qquad (13)$$

These are the general slope deflection equations for member 1–2, expressing relations between end moments, end rotations, relative deflection and applied loads. They involve, in this general case, areas bounded by curves, also the centers of gravity of these areas. Determination of these elements by decomposition of areas into trapezoids will be found of ample accuracy in every case.

The following expression, giving the shear H in member 1–2 in the absence of superimposed loads, $(A = 0)$, is derived from equations (13):

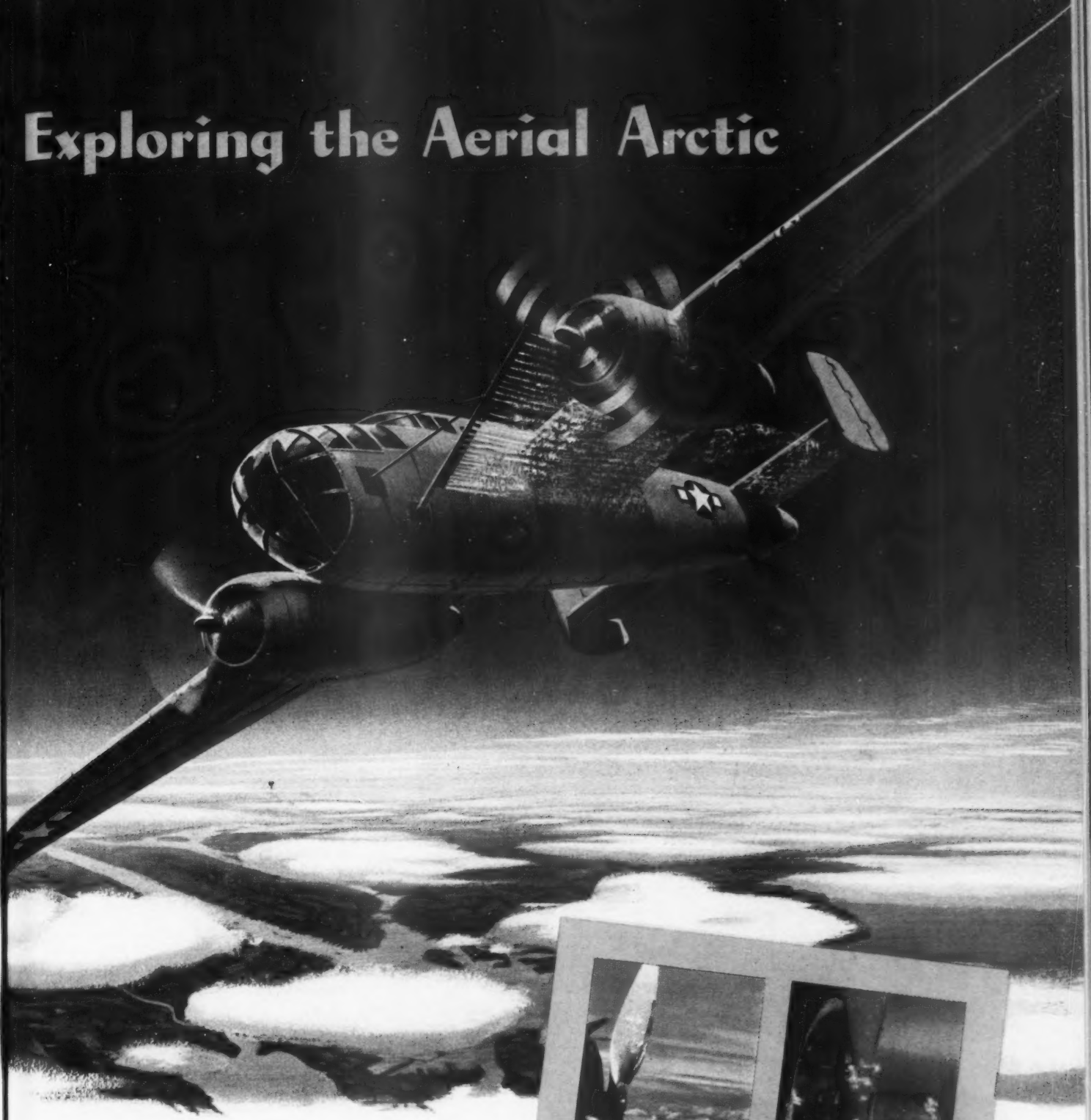
$$H = -\frac{M_{12} + M_{21}}{l} = -\frac{1}{(c_2 - b_2)}\left[\frac{\omega_1}{C} + \frac{\omega_2}{B} - R\left(\frac{1}{B} + \frac{1}{C}\right)\right] \qquad (13A)$$

Fixed-End Moments, Stiffness and Carry-Over Factors

Equations (13) will be used to bring

(*Turn to page* 328)

Exploring the Aerial Arctic



Above: B-25 test airplane with water-spray outrigger for inducing ice.

Kodachrome photographs of feathered Curtiss Electric Propellers at 20,000 feet record the ice formations.

Constant study of ice prevention and elimination is one of the many phases of Curtiss Propeller flight research.

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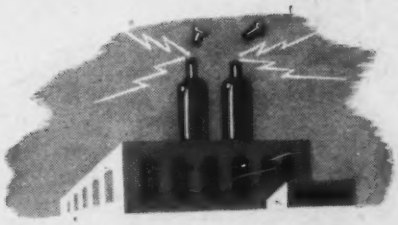
TO WIN THE WAR—*Work—Fight—Buy War Bonds!*

Plant Power— Minus the Bottlenecks



By **W. D. DRUMMOND**, *Switchgear Specialist, Westinghouse Electric & Mfg. Co., Cincinnati*

When vital war production must be maintained day in and day out, power and lighting emergencies become intolerable. So Wright's Ohio engine plant called for an electrical distribution system that would be dependable—*plus*. Here's how that order was filled.

WRIGHT AERONAUTICAL CORP.'S aircraft engine plant in Ohio was designed for continuous operation—three shifts a day, seven days a week. Hence, to meet any emergencies (such as sabotage, fire, explosions, or apparatus failures) with the least possible loss of production time, no bottlenecks could be tolerated in the design of the electrical system.

A system must not become too complex; for if it does, the business of getting back to normal after a major disturbance would be too difficult. The more complicated the system, the more highly skilled must be the operating personnel.

Once the relative importance of the elements of the system was determined, it was a matter of good judgment in balancing the investment against the degree of reliability gained by a given system. This determined the extent of the duplication of feeders, looping of primaries, interconnection of secondaries, and the amount and type of switchgear.

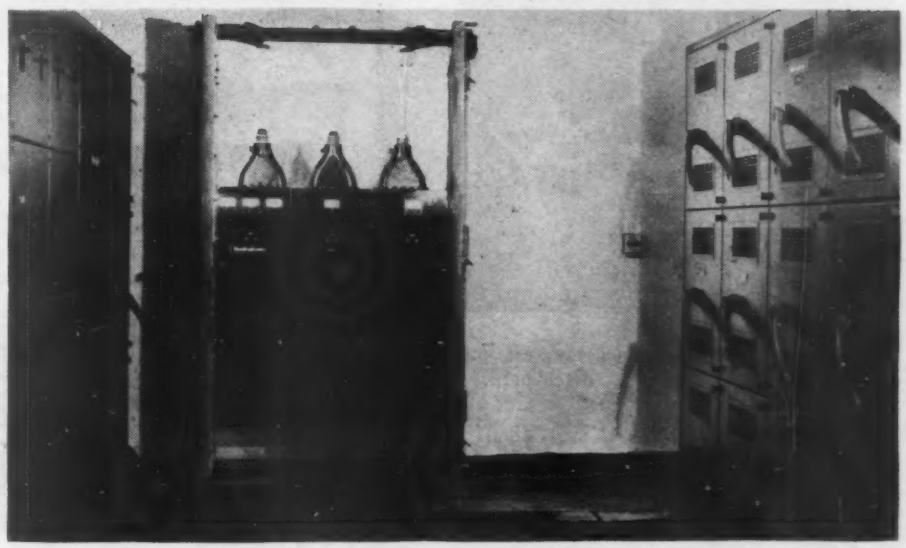
Another thing: Growth of this and other war plants is unpredictable under present conditions, and many of these plants will turn to the manufacture of entirely different products in the coming peace. This consideration constitutes a further demand for maximum flexibility of the system adopted so that changes and additions can be made with the least expenditure of time and money and with no disturbance to existing production lines.

Disregarding their relative importance, the points in the electrical system at which bottlenecks of reliability and flexibility are most likely to occur may be listed as: (1) primary power supply, (2) main power supply to plant substations, (3) primary and secondary switchgear in the plant substations, and (4) the power and lighting transformers themselves.

The primary supply demands the ultimate in reliability of service. At least two sources of primary power are required to insure having power available at all times. In general, use of two paralleled supply lines to carry the entire plant load is avoided in war plants. Since the two supply lines usually originate at independent points on the public utility system, they must nearly always be synchronized before being tied together. In case of failure of one line, the plant would be at half capacity until the utility company could be notified and the lines re-synchronized.

The "preferred-emergency" scheme

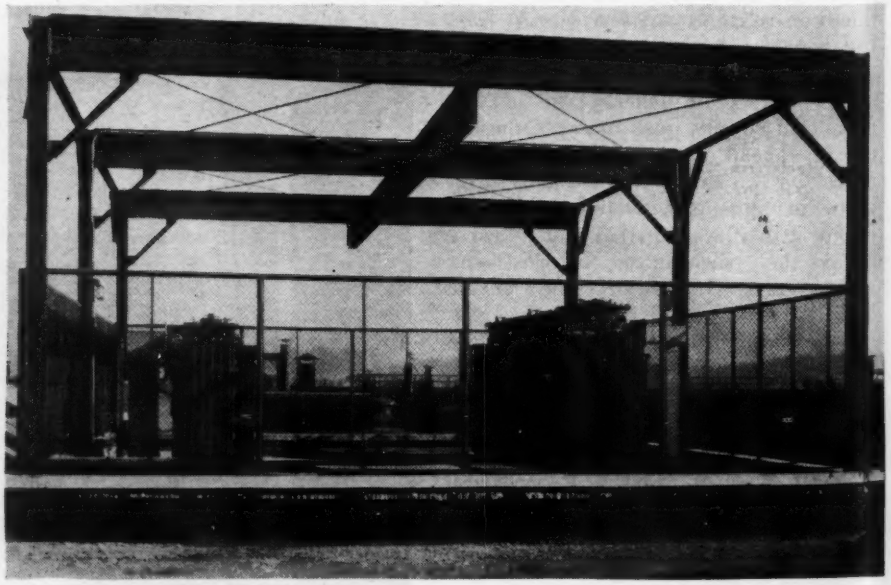
Metal clad switchgear in main substation.



General view of switchgear in typical plant substation. Seen are 440 v. power switchboard (right), 208/120 v. lighting switchboard (left), and 13,200 v. metal clad switchgear (center).

Typical 440 v. power switchboard in plant substation with draw-out type air circuit breakers.

Close-up of draw-out type network protector in 208/120 v. lighting switchboard.



Typical roof-mounted outdoor power and lighting transformer substation.

supply might be dead when most needed.

The more reliable system of supply uses two continuously energized full-capacity lines each connected to its own load bus. Each bus can carry the entire load. Normal operation is to divide the load so that if one line or bus fails only half the load is lost—and that only so long as it takes to switch the "lost" load to the unfaulted bus. This is the plan used in the master substation at the Wright Aeronautical plant. The switchgear in the master substation is the metal clad type using 250,000 kva. interrupting capacity, electrically operated, vertical lift oil circuit breakers.

For maximum production, power must be uniform throughout the plant. To obtain uniform voltage regulation, it is necessary to bring power to the center of the load areas at high voltages and to keep to a minimum the length of the low voltage feeders to individual loads. Because of better voltage regulation full voltage starting of large motors permitted the use of inexpensive and simplified control and the use of fluorescent lighting.

The primary distribution voltage was selected to correspond with the local utility distribution voltages. It is to be remembered that war plants extend over large areas. Based on the load and the distance from the master substation to the plant substation, and using the available voltages of the local utility company, it was found that the load in the original group of buildings could be served most economically at 13,200 v.

With the increased load due to the recent expansion of the plant the supply voltage was changed to 66,000 v. and stepped down to 13,200 v. through two duplicate 20,000 kva. 3-phase transformers located in an outdoor switchyard and using the original master substation 13.2 kv. switchgear, except for the addition of two new feeders.

This change was accomplished while

employs the use of two incoming sources, each with sufficient capacity to carry the whole plant load but with only one connected to the load at a time. Objection to this system is that the emergency

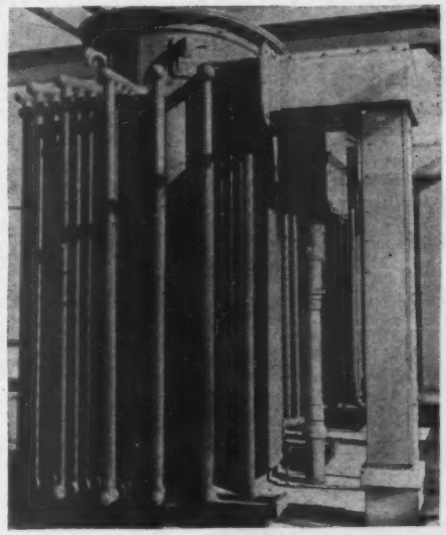
the plant was in full production, and savings in losses more than offset the increased cost of the high voltage switchgear and cables.

Duplicate 13.2 kv. feeders, one from each of the two plant buses in the master substation, serve the same group of two or more plant substations. Normally the two or more plant substations in a group are divided between the two feeders; but if one should fail, all the substations in that group can be switched to the remaining feeder.

At each plant substation there are three electrical systems to be controlled. These are the 13,200 v., 3-phase, 60-cycle primary distribution to the power and lighting transformers; the 480 v., 3-phase, 60-cycle distribution and interconnections, and the 208/120 v., 3-phase 4-wire, 60-cycle lighting distribution and network system.

Each plant substation consists of primary switchgear, separate 3-phase transformers for light and power, and the low voltage distribution switchgear. The ultimate installation at each substation will be two 500 kva. 3-phase lighting transformers and four 750 kva. power transformers.

Power and lighting transformers are located on roof areas, where they consume no production space and where the "rental charge" to the electrical department is lowest. Excellent ventilation is obtained without the use of fans and air cleaning equipment.



Close-up of 3-phase power transformers. High voltage cables and low voltage bus duct enter plant substation switchgear room directly below.

The primary switchgear and the secondary switchboards are located directly below the transformers so that the primary and secondary connections from the switchgear to the transformers are short and in only one direction—straight up.

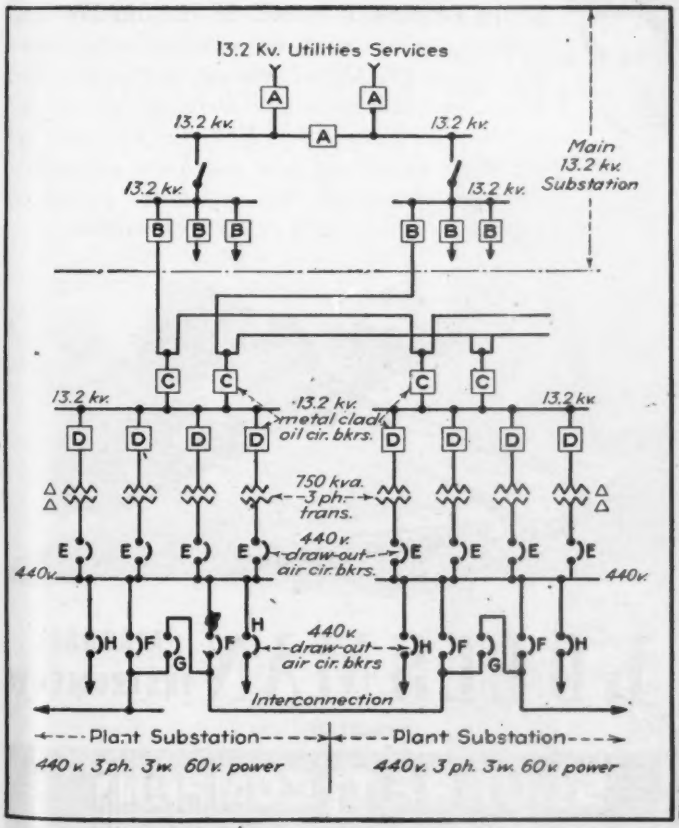
Each primary switchgear is of the indoor metal-clad type consisting of eight units using manually operated non-automatic vertical lift oil circuit breakers of 100,000 kva. interrupting capacity. Four feeders circuits to power transformers, two circuits to lighting transformers, and two incoming line circuits are controlled from each group of primary switchgear.

The two incoming line breakers are mechanically interlocked so that only one breaker can be closed at a time. As stated before, there are two plant buses in the master substation. Both are always energized but cannot be tied together. Leaving the master substation are two feeders to each predetermined group of two or more plant substations, one from each plant bus. However, the two interlocked incoming line breakers at the plant substation allow the substation to be energized from only one of the main plant buses at a time.

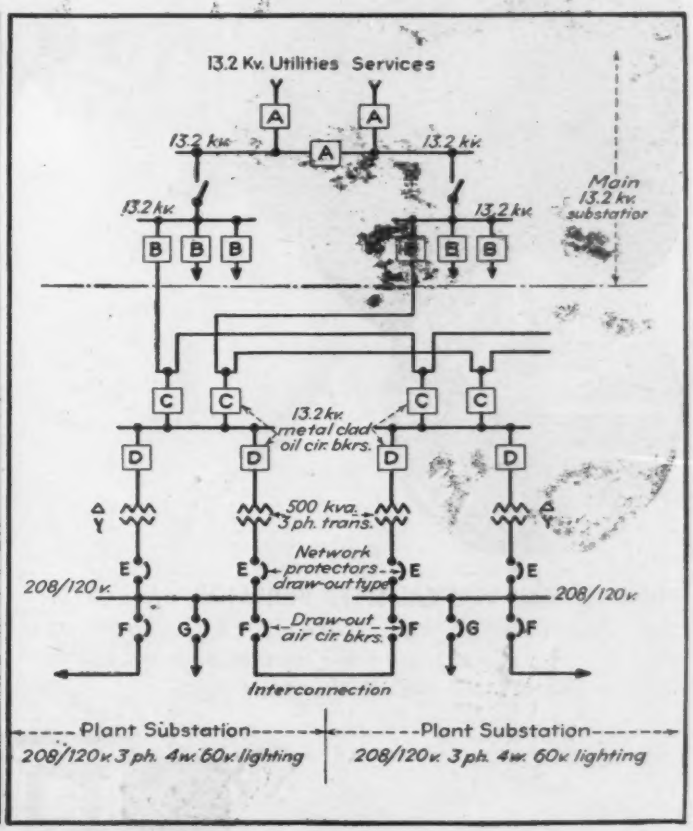
This arrangement permits the equal loading of the master substation buses by shifting the heavily loaded substations and the lightly loaded ones so as to balance the entire load on the two plant buses. A further advantage is that the open breaker may be substituted in case of failure of the closed incoming line breaker.

The low voltage power distribution switchboards are of the metal enclosed type using manually operated draw-out air circuit breakers. All breakers are of 50,000 amp. interrupting capacity. There are four transformer breakers, two station tie breakers, one by-pass

(*Turn to page* 316)


13.2 Kv. Utilities Services
13.2 kv.
Main 13.2 kv. Substation
metal clad oil cir. bkrs.
750 kva. 3 ph. trans.
440v. draw-out air cir. bkrs.
Interconnection
Plant Substation
440 v. 3 ph. 3 w. 60 v. power

Schematic diagram of power interconnections.

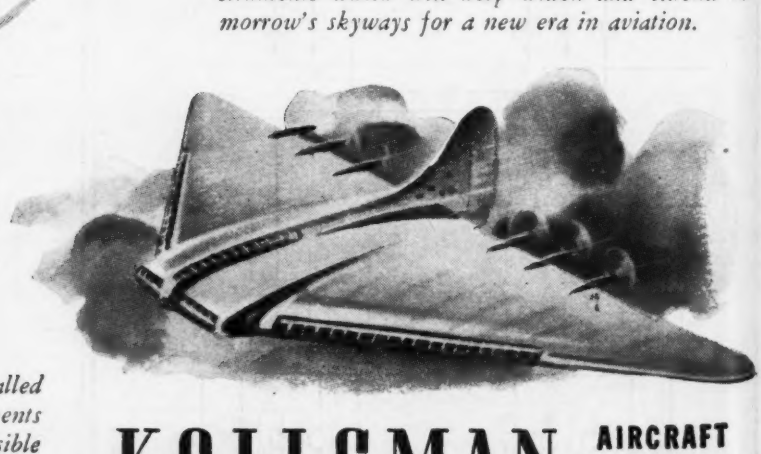


Schematic diagram of lighting interconnections.

Comfort by the foot...

AN air transport plane bristles with gadgets for a passenger's comfort . . . from individual "air-conditioning" to non-skid paper "pantaloons" for the pork chops. But some of the most important contributions to passenger comfort are never seen—a set of "comfort instruments" in the cockpit. The rate-of-climb indicator, for instance, gauges the gradual 300-feet-per-minute descent at all airports, which saves passengers from the discomfort of a too-rapid change of air pressures. The accelerometer is another "comfort gauge"—measuring the relative roughness of the air, assisting pilots in keeping to the smoother flight levels . . . and the sensitive altimeter helps them maintain those comfort levels. In the design and engineering of such precision aids to aircraft operation and navigation—civil and military—Kollsman has excelled for fifteen years.

IN THE PASSENGER PLANES OF TOMORROW—*with their pressurized cabins and other comfort features—instruments will play a larger part than ever before, expanding their scope and usefulness far beyond anything we know today. Kollsman engineers are constantly developing new and better aircraft instruments which will help widen and extend tomorrow's skyways for a new era in aviation.*



THE KOLLSMAN VERTICAL SPEED INDICATOR, *often called the "rate of climb" indicator, is one of the basic instruments for maintaining level flight when the horizon is not visible and for learning the rate of altitude change.*

KOLLSMAN AIRCRAFT INSTRUMENTS

PRODUCT OF

SQUARE D COMPANY

ELMHURST, NEW YORK • GLENDALE, CALIFORNIA

Convair's "plant-within-a-plant" keeps production lines rolling by doing or making anything under the sun. Here, for example, are special-order sheet metal parts ready for inspection and rush delivery. Quantities ordered may run from one to several hundred.

This Plant-Within-Plant Assures Peak Production

"Little CV" salvages, fixes, and builds anything—quickly nips production-flow jams before they can begin. Making the unusual normal and emergencies routine is the particular knack of this miscellaneous parts department, and the maxim of its skilled staff is "Name it and you can have it."

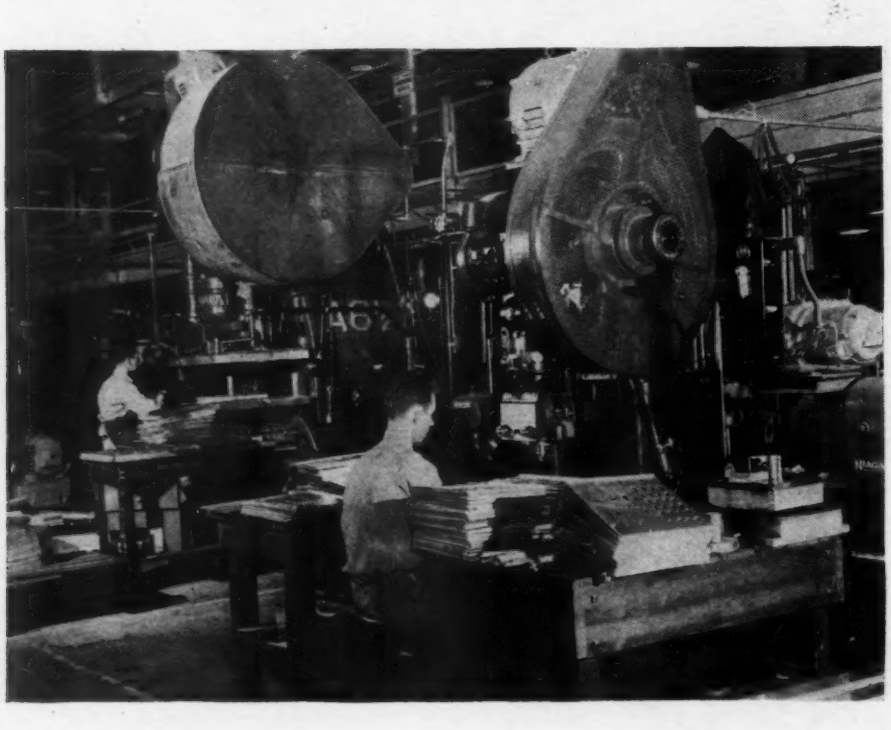
THE MISCELLANEOUS PARTS DEPARTMENT of Consolidated Vultee's San Diego plants has earned its nickname of "Little Consolidated Vultee" by being, in effect, a virtual plant within a plant In miniature, it duplicates almost all of the production capacities of the San Diego division in the fabrication of parts and small subassemblies.

In addition, it functions as a small salvage department, a neighborhood "fix-it" shop to handle emergency repairs to tools and machinery whose continued disability would seriously hamper the flow of production, a job machine shop for building experimental tools and jigs, and a spare parts manufacturing plant to supply extra parts for current models and for those planes of an earlier period which are still in active service around the world.

As if this were not enough, the miscellaneous parts department is also given the job of repairing the various parts, large and small, that have been damaged in production, that have been orphaned by design changes, or that have been misworked by other departments or subcontractors but which can be reclaimed by a little expert tinkering. Damaged parts may range from

Typical of varied work turned out by machine tool section of miscellaneous parts department at Consolidated Vultee's San Diego Div. are these on final inspection bench. They include pulley bracket castings, nose wheel casting, milling machine arbors, punch press dies, hi-cycle drill bushings, draw-in collets for bench lathes, and variety of blanking dies.

Duplicating in miniature nearly all facilities for fabrication of parts and small sub-assemblies, "Little CV" has but one cardinal rule: Orders must be in writing. Part of machine tool section is shown in foreground, portion of sheet metal section in right background.



Spare parts orders often don't run according to schedule. So, to help keep *Liberators*, *Catalinas*, and *Coronados* in service throughout the world, plants' "fix-it" shop steps in on short production runs, such as this blanking operation on airframe subassemblies.

a bent back on a pilot's seat to the entire outer wing panel of a B-24 *Liberator* bomber.

Altogether, there are nine classifications into which the activities of the department tend to fall. But within these general groups there are complex variations of work which result from the fact that no job is sent to this department unless it is an emergency of some sort or is a problem that has baffled other departments.

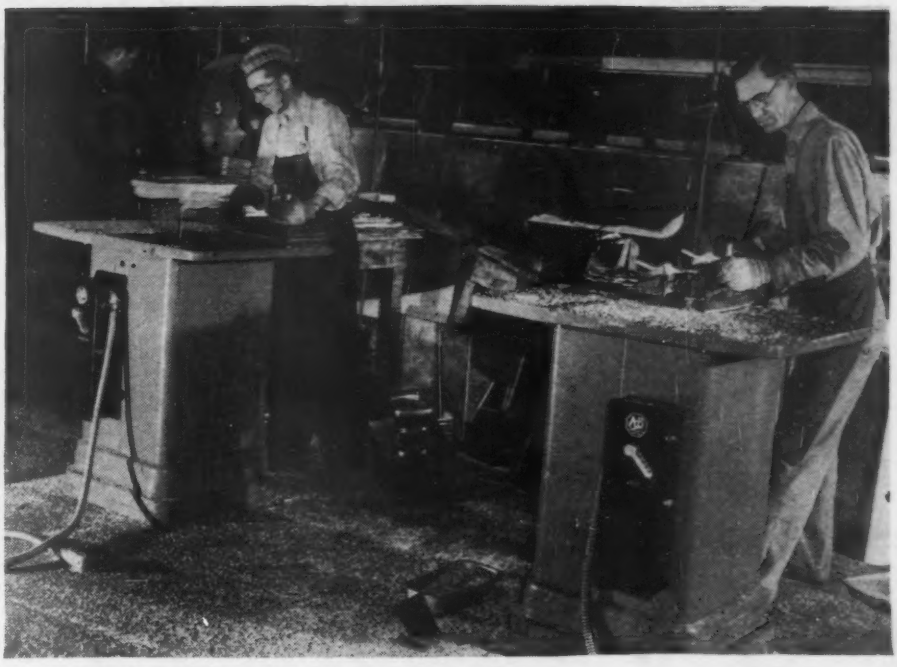
Actually, there are two such departments in the San Diego division; one serves Plant 1, the other Plant 2. Although there are some differences in

equipment, personnel and type of work handled by each (the result of Plant 1 being engaged largely in assembly while Plant 2 is devoted entirely to the manufacture of parts and subassemblies) the general operation of both is sufficiently similar that they can be discussed as one unit.

The only fixed rules governing operations at miscellaneous parts are that all orders for work must come from production control in writing and that its members draw regular pay checks at the same time as other Consolidated Vultee employes. Beyond these two points, anything can happen—and frequently does—in the course of dealing with one production crisis after another day after day. It is a department where the unusual is the normal, where emergencies are routine, where improvization is the rule, and where no one gets bored by having to do the same old thing in the same old way day in and day out.

Here, for example, are a few of the orders that come flooding in at the start of any ordinary day:

Metal bench needs a drill fixture . . . . Sheet metal wants a production sample; is returning one made yesterday for alteration . . . . Fabrication calls for a multi-punch bar . . . . The tool department says, "Rush 20 drills" . . . And (take a breath) Production must have a Micarta strip, a rubber insulation strip, a collar for the nose wheel emergency lock, a latch for the rear gun stowage, a latch for the nose landing-gear down lock, a bracket for engine control pulleys, 100 screws with slotted heads, 50 channels for bomb racks, a chrome moly spacer, and two drill templates . . . . What's more, there are also orders for a wood router form that will be scrapped when the permanent tool is completed, a dural form block for temporary use, a Kirksite die for permanent tooling, and 12 scarf mill table clamps.



Routing of sheet metal parts on a production order. Request for this job arrived with order for emergency repair of regular production tool.

This by no means exhausts the list, but the items are representative. Not included are the orders for the salvage of parts, fastenings, and fittings. For instance, there's that box of bolts orphaned by a design change. By cutting these bolts down to 3 in. and re-threading them, they can be returned to stock for use on another ship. Five pilot's seats are on another bench. In shipping the backs were bent. They will be taken apart, the damaged parts replaced, and the seats returned to stock as good as new.

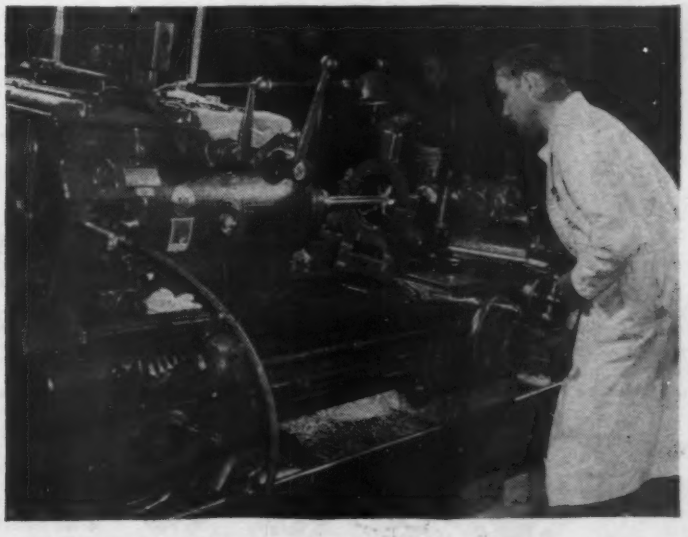
To handle this multitude of problems a crew composed of tool and die makers, machinists, sheet metal workers, and expert assemblers has been gathered and trained to work as a team. Eligibility to work in this department demands skill, versatility, the requisite common horse sense, and plenty of mechanical imagination.

Among the materials regularly worked in "Little CV" are all the aluminum and magnesium alloys, wood, steel, brass, copper, rubber, Kirksite, and plastics. These may be in bars, rods, tubes, sheets, castings or forgings.

Tools employed include lathes in all sizes from inexpensive 9-in. bench mod-

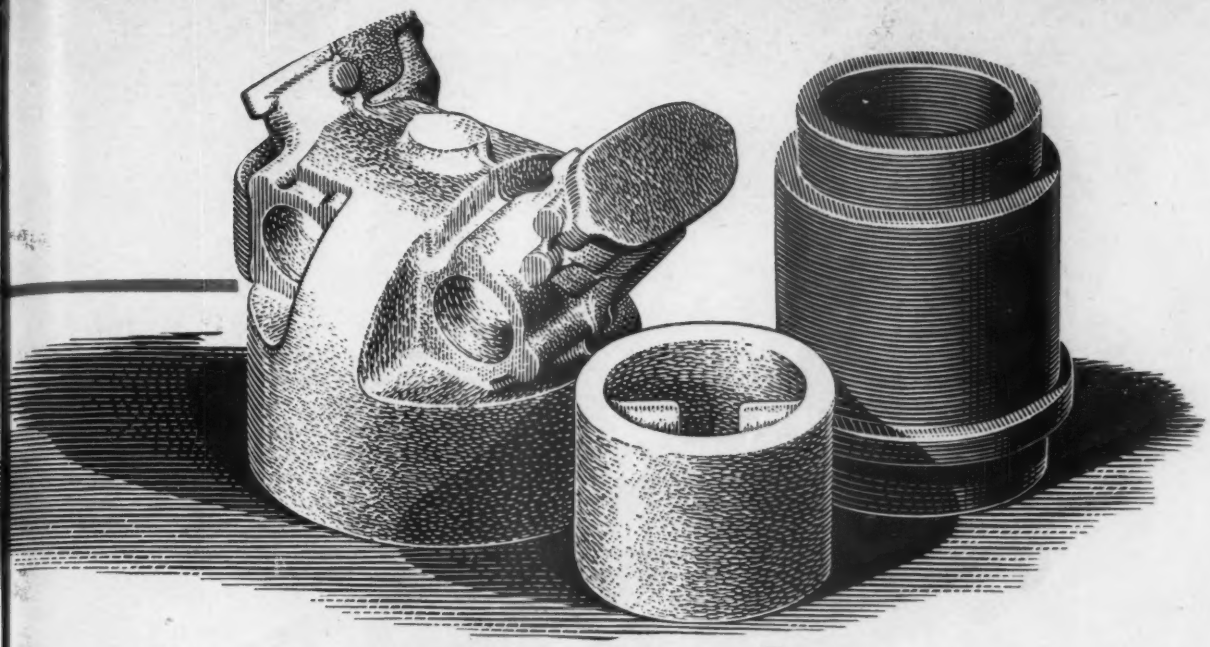
(*Turn to page* 299)

On some orders one man will follow through from receipt of written order to delivery and to inspection—such as with this repair job on Z-section joggle of punch press. Other work, however, may require teams of several of department's skilled technicians.



Established to eliminate bottlenecks by salvage, repair, or manufacture, miscellaneous parts does anything from rough carpentry to machining operations down to .0001 tolerances. Here, milling machine arbor is turned on 30-in. lathe.

Precision heat treating of



Aluminum Alloy and Steel

AIRCRAFT FORGINGS

Precision heat treating is the *Siamese twin* of expert forging. Both are indispensable in Tube Turns' large scale production of aluminum cylinder head, aluminum piston and steel barrel *forgings* (shown above).

These are no ordinary forgings. Their end use is crucial. Their production must be flawless. *Accurate heat treating* is especially imperative, because allowable variations from specified hardness are extremely small in these vital parts. At Tube Turns, we maintain exceptional production and laboratory controls over *every* heat treating step to assure the best possible grain structure. And we do it in step with pressing, around-the-clock production schedules.

Tube Turns has earned a unique reputation for turning out difficult aluminum and steel forgings with seemingly impossible precision and promptness. We shall welcome inquiries from forward-thinking engineers and manufacturers who need forgings, or forging ideas, now or in the future.

TUBE TURNS (Inc.) **LOUISVILLE, KENTUCKY**

TUBE TURNS

Forgings for Industry

ARMY (E) NAVY

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Wherever you find the Navy, you find Berryloid-finished fighters and bombers. No other branch of our fighting forces demands greater protection and durability in finishing materials. More than a quarter century's experience has proven to Navy specifications officers and inspectors that no other finishing materials combine so many performance and application advantages. Berryloid is the standard of quality everywhere.

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AIRCRAFT FINISHES

Women being trained for Vega engineering jobs in alternate nine-week terms at California Institute of Technology and in company shops come in practical contact with classroom trainer plane. Lucia Van Buskirk, former interior decorator, records a measurement taken by 21-yr.-old Martha Robertson, fresh from college.

Engineers Made to Order

By **E. V. GUSTAVSON**, *Personnel Engineer, Vega Aircraft Corp.*

With trained technical personnel at a premium and becoming scarcer, Vega has established special courses to adapt the inexperienced and the unskilled to specific aircraft production jobs.

THERE CERTAINLY AREN'T enough trained engineers. At the same time that increased production has required more of them, the supply of technically trained men has not only been inadequate but is even decreasing.

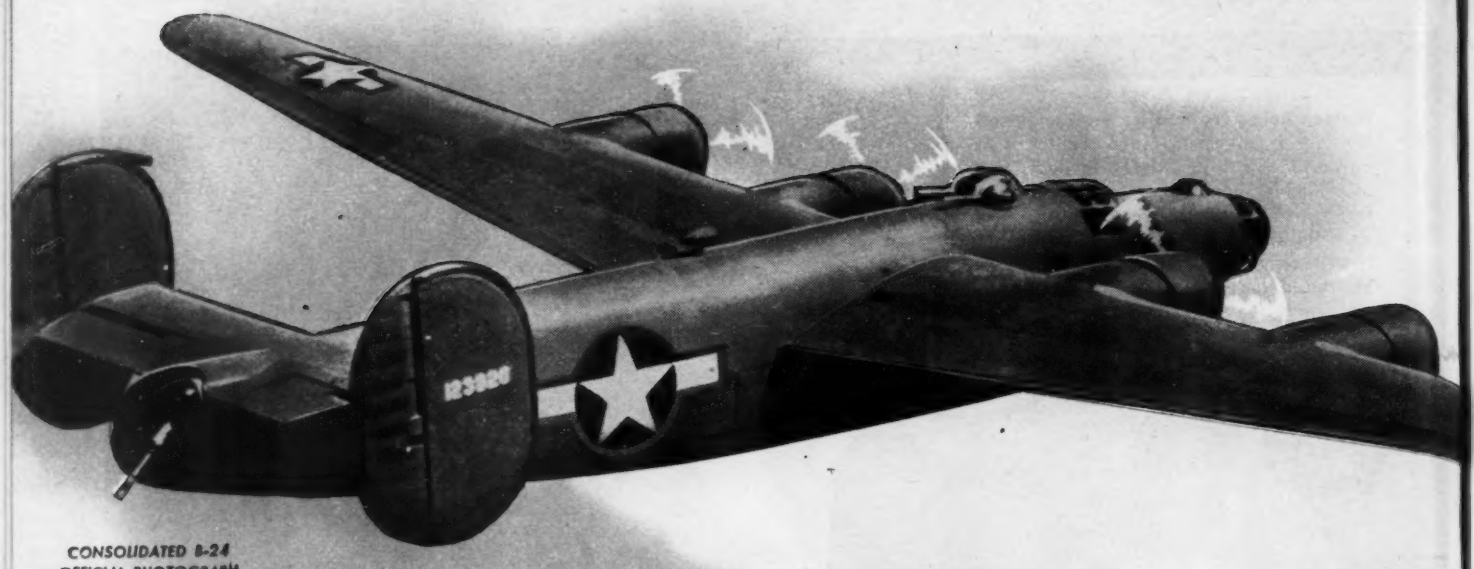
Every aircraft company is faced with the distressing fact that the armed forces are absorbing a large percentage of engineering graduates while the number of experienced men in the industry itself is diminishing.

To counteract this shortage, Vega Aircraft Corp., as in the past, is now training selected students in supervised specialized courses.

Recently a new, streamlined training program with a long-range objective was instituted. With the cooperation of California Institute of Technology, Warren G. Furry, Vega staff engineer in charge of training in the engineering branch, organized a full time, 52-wk.-course in aircraft engineering fundamentals now being given to forty engineering employees. This course is designed to furnish the minimum technical education required for the selectees to be upgraded to jobs requiring more experience or training.

All subject matter is of college level and is being taught by instructors of Cal. Tech. and engineers from Vega. The courses have been stripped of all non-essentials and concentrated so as to approximate a full college course in the engineering subjects chosen.

Special emphasis is made on layout practice, mathematics (including calculus), aerodynamics, and structures. Shop work is also featured, as well as design changes which are demonstrated on the all-metal training plane at the school. In addition, lectures are being given by Vega engineers on selected subjects such as process and production engineering, materials, hydraulics, structure design, and stress analysis. Thomas V. Davis, Vega engineer, is on loan to



CONSOLIDATED B-24
OFFICIAL PHOTOGRAPH
U. S. ARMY AIR FORCES

MAKE THEM MORE AND MORE AUTOMATIC

TO INCREASE THEIR FIGHTING POWER★★

White-Rodgers automatic temperature modulation equipment relieves pilots for greater concentration on fighting power by providing completely automatic control of:

1. **Engine cowl flaps (both air and liquid cooled).**
2. **Oil cooler shutters or flaps.**
3. **Cabin temperature (both super-charged and normal).**
4. **Carburetor air temperature.**

Upon request, engineering data will be furnished to manufacturers requiring controls for the above or other temperature applications.

LET'S GO! U.S.A. · KEEP 'EM FLYING!

WHITE-RODGERS ELECTRIC CO.

SAINT LOUIS, MO.

the Institute as coordinator of the program and instructor in certain specialized aircraft subjects.

An unusual feature of this course is that the engineering employees attend classes full time for nine consecutive weeks on the company payroll at their regular rates and then return to project work in the engineering branch for an alternate nine-week period. The advantage of this plan is obvious. It gives a constant check on the adequacy of the training and on the progress being made by each student.

The training group is divided into two sections of twenty members each. While the over-all program requires a year, the total time spent in training is thus only six months in alternating nine week periods. The first section studies while the second practices.

Layout practice is also given considerable time in this one year work-practice course being given to 40 women.

The Women Win

Prior to the inception of this program, the training section of engineering personnel interviewed supervisors of the various design projects to obtain draft exempt selectees with the desired qualifications. All of the final selections were women. Special consideration was given to personality, adaptability, and leadership, in addition to quality of work and progress made.

A total of 130 women were selected from original interviews with supervisors. Each received a questionnaire on which the proposed training course was outlined. The candidate was asked to check a list of subjects allied to engineering and indicate those in which she had completed at least one course. The questionnaire also contained space for previous experience, including past work at Vega.

Returned were 125 questionnaires. From these, it was found that approximately seventy-five women had completed college mathematics through trigonometry and that some two dozen had taken mathematics through calculus.

Approximately three weeks were devoted to making the selection of the twenty women who were to form the first group. Supervisors were again consulted on the information furnished through the questionnaires. Each of the 125 women was interviewed individually and, in some cases, jointly with her supervisor.

When the final selection for the first class had been made, the twenty women were given an examination in mathematics which covered fundamentals of algebra and plane geometry. The purpose of this test was to determine the needs of the group so that the mathematics course could be planned to cover them. The women were also given a mechanical aptitude test to ascertain their rating at the beginning of the course. A similar test is given at the end of the period to note whether or not aptitudes improve with training.

Of the twenty initially selected, six had college degrees, two had completed three years of college, three two years, and four one year. Four had finished high school, and one had had seven years of training at an art institute.

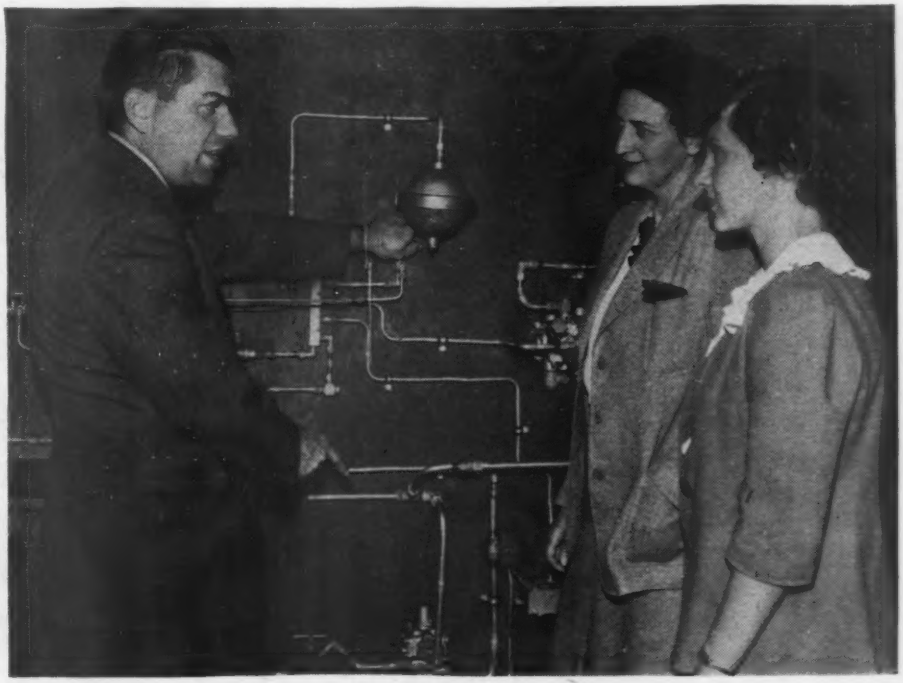
The age range was 18 to 49 yr. Fourteen of the women are single; five are married. The average length of time the group has worked for Vega is seven months, the longest eighteen months. Past experience includes interior decorating, laboratory work, teaching, buying, bookkeeping, secretarial, accounting, pattern designing of crystal ware, acting, sub-division mapping, and homemaking. Qualifications and experience of the second training group of twenty follow closely those of the first group.

Engineers Converted

The problem of training first confronted the Vega engineering branch in the spring of 1941. At that time it was necessary for the branch to undertake a rapid expansion out of proportion to its then relatively small size.

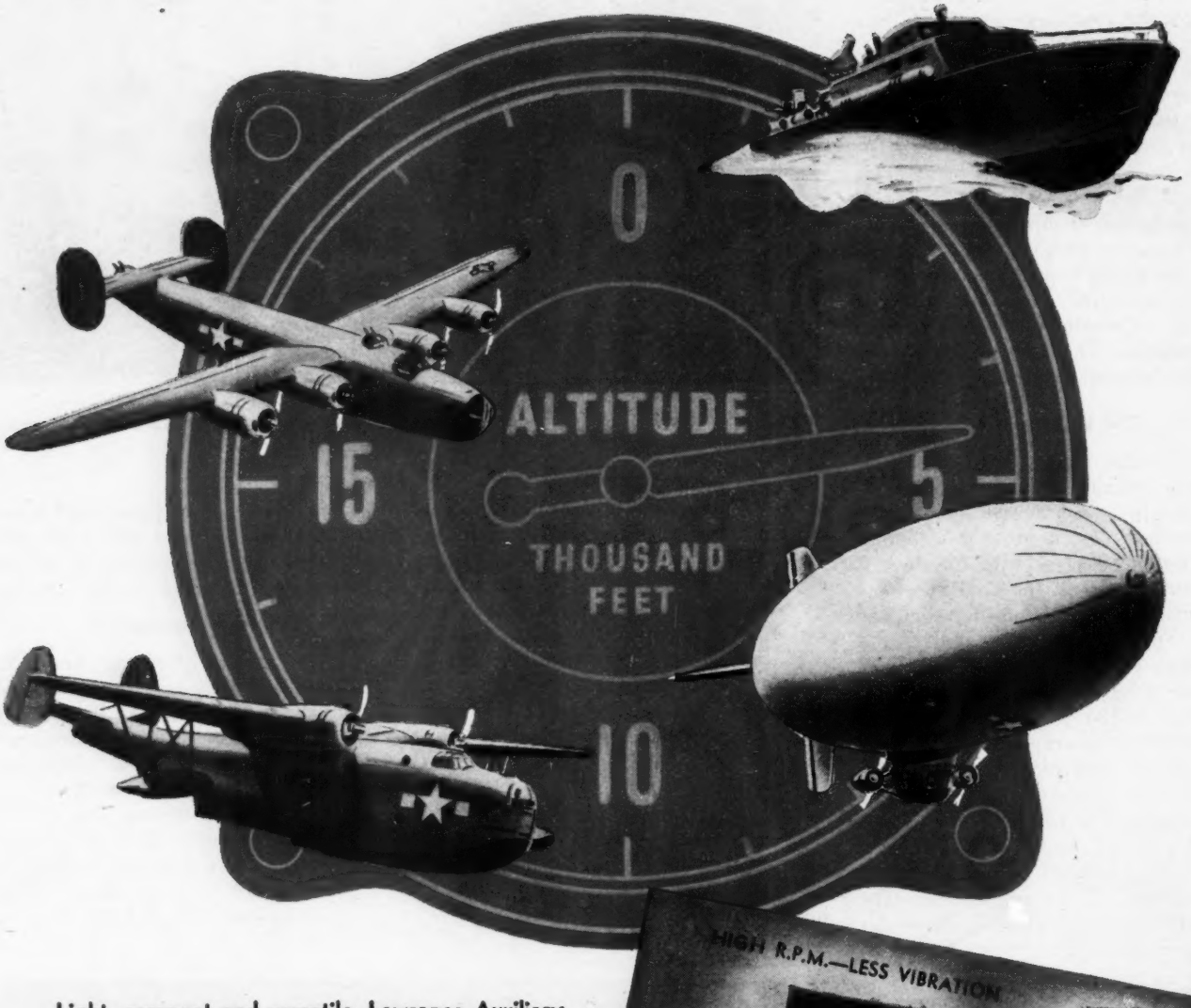
With companies facing war expansion, a major problem was the procurement of engineers capable of carrying aircraft design responsibility. Vega

(*Turn to page* 253)



Details of hydraulic system are traced for Students Gladys Auld and Edith Brownwood by Ellis Wampler

MEETING EVERY *Auxiliary Power* NEED



Light, compact and versatile, Lawrance Auxiliary Power Plants are now serving aboard aircraft, tanks, blimps and PT boats, producing a dependable flow of electrical power to perform a multitude of vitally important duties. There is a Lawrance model, designed to the special requirements of its installation, to meet every Auxiliary Power need. The quality that is built into every Lawrance Auxiliary reflects a background of research and engineering experience unsurpassed in the field. Look to Lawrance for Auxiliary Power.

LAWRANCE POWER

Lawrance AUXILIARY POWER PLANTS

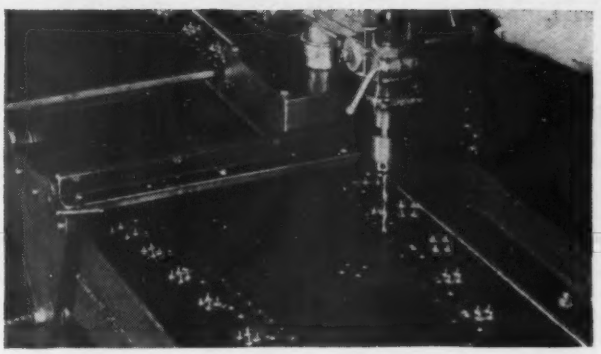
LAWRANCE ENGINEERING AND RESEARCH CORPORATION • LINDEN, NEW JERSEY

Noorduyn Production Time-Savers

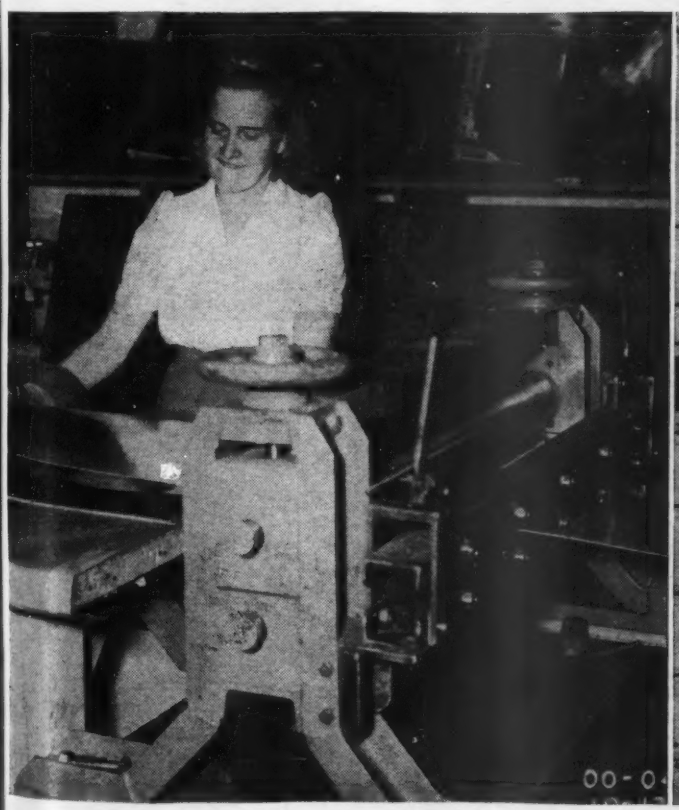
By JAMES MONTAGNES
"Aviation's" Canadian Correspondent

How new "twists" speed up "Harvard" and "Norseman" output.

IDEAS WHICH ARE SAVING TIME, materials, and labor in manufacture of NAA *Harvard* trainers and of Noorduyn *Norseman* (U. S. Army UC-64 utility cargo transport) are shown on this and the following page at work in the Montreal plant of Noorduyn Aviation, Ltd. Other practical developments (not pictured) include construction of router templates with metal tips instead of conventional $\frac{5}{8}$ in. metal countersinking of nut-plates, saving 6 hr. formerly required to countersink plates on every plane; and covering surfaces around doors with masking tape when Neoprene is cemented in place, saving 15 min. per door.

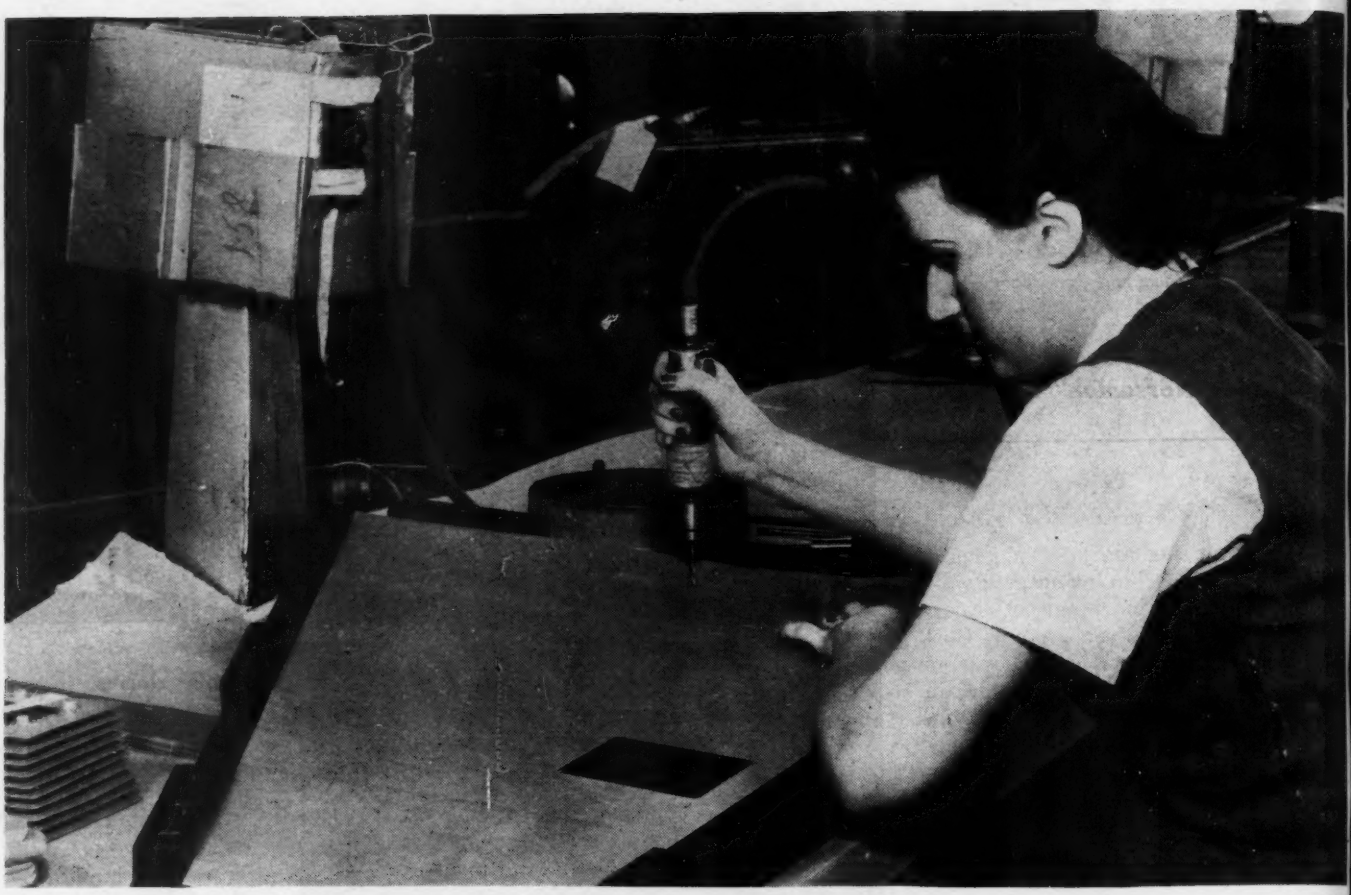


Toggle clamps (above) instead of thumb screws hold four instead of one wing center plate in jig. One man works drill press (left) which rolls along edges of jig, replaces two workers with hand drills. Jig can be inverted for drilling holes from back. Production increased 240 percent while 140 hr. were saved for every hundred plates made.

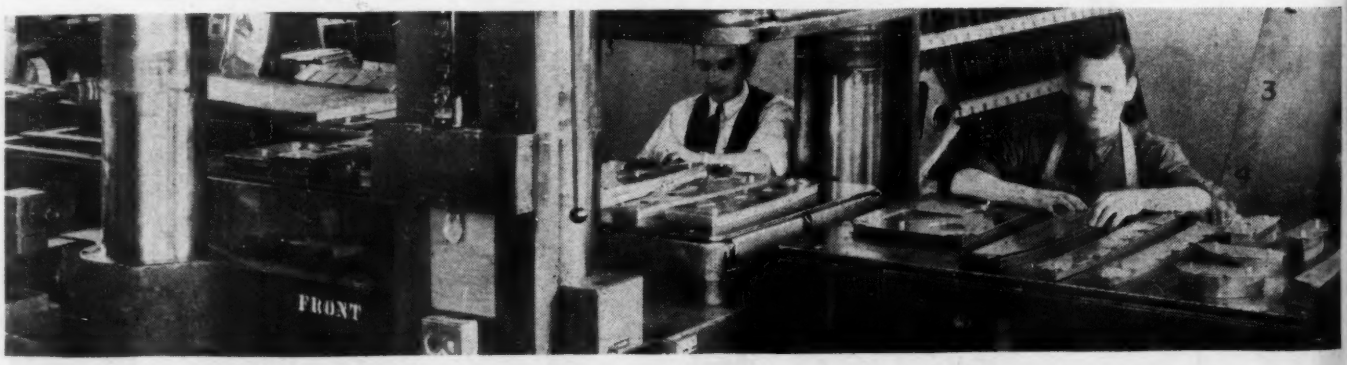


Roller machine reminiscent of laundry wringer squashes down and breaks off burrs around holes drilled in aluminum sheet. Job formerly required work on every hole with hand drill.

This squeeze riveter eliminates the bucker. And suspension cable seen here supporting the heavy tool makes the work light enough for a woman.



Replacing man who used to measure and cut holes in prefabricated stringers and gussets for horizontal stabilizers, this girl lays same parts out in Masonite jig. Then she fastens previously-drilled skin over them with screws. Drill inserted through holes in skin thus cuts stringers and gussets in proper alignment.



With two tables (above), one being loaded while other is used, this 1,320-ton sheet metal forming press is kept in continuous operation. Loaded table automatically pushes one with finished parts out of way. Safety devices include photo-electric eyes.

Jigs suggested by workers have increased prefabrication speeds of cantilever subassemblies on NAA *Harvard* trainers. Result: Two shifts now produce as much as eight or ten used to.

How LIGHTER airplane tires carry HEAVIER loads

RAYON BODY

Tire Weight . . . 100%

Tire Strength . . 100%

NYLON BODY

Tire Weight 96%

Tire Strength . . 164%

UNITED STATES RUBBER COMPANY

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These Four Great War Planes S

Tires Now Carry A

HOW "U. S." TIRE ENGINEERS ANSWERED THE NEED FOR TIRES THAT CAN TA

P-39 Bell Airacobra—From its first, dramatic introduction in 1940, the P-39 with its tank-destroying 37mm. cannon has been among the fighting favorites of our Army Air Forces and those of our Allies. It has proved its fighting power in the Aleutians, the South Pacific, North Africa, Russia—in every theater of the war. When first produced, its rated gross weight was about 6000 pounds.

Today with heavy machine guns replacing light, with bullet-sealing fuel cells instead of aluminum tanks, with greater stores of gas and ammunition and added plane and pilot armor, this fighter today weighs 7404 pounds.

But the same size tire, 26 x 6, had to carry the load. Tires with cotton cord bodies would not do the job. "U.S." tire engineers, who pioneered rayon cord tires with the Army and Navy air arms, *decreased* tire weight, added the stamina needed to carry a third more weight—without adding even a fraction of an inch to the over-all tire size.

P-40 Curtiss Warhawk—The record of the "Flying Tigers" knocking ten enemy planes out of the sky to one Warhawk lost, added to distinguished performance in every theater of the war, entitles the Warhawk to a place in the front line of America's great war planes.

Armed at first with but two machine guns firing through the propeller, today's P-40 carries six heavy guns, a thousand-pound bomb load and heavier armor protection for the plane and pilot. Bullet-sealing fuel cells, heavier, more powerful engines and super-chargers, along with other new equipment, have raised the 1940 weight of 6789 pounds to 9000 pounds today.

The 30" tire size that carried the original weight has been engineered to carry this increased load at higher landing speeds. Again, lighter U.S. Royal Rayon Cord tires replaced heavier cotton tires that could not shoulder the load. And not one fraction of an inch was added to the over-all tire size.

UNITED STATES

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Listen to the New York Philharmonic Symphony broadcast over Columbia network every Sunday afternoon 3:00 to 4:30 P.M. EWT.

Show How Lighter, Stronger

As Much As 50% More Weight

TAKE THE INCREASED WAR LOAD . . . WITHOUT INCREASING TIRE SIZE

B-24 Consolidated Liberator—Over the Ploesti oil fields and the railway yards of Rome, over every Axis center of war activity, the Consolidated Liberator has made the might of American air power felt with devastating effect.

In 1940, the B-24 was rated at 41,000 gross weight. Today, published figures rate it at 65,000 pounds, an increase of over 50%. From a half-dozen machine guns to a complement of over a dozen with four power turrets, from aluminum gas tanks to bullet-sealing fuel cells and with ten tons of bombs, this great bomber has grown into one of the most potent offensive weapons of the United Nations.

Even with a 50% increase in load, the 56" tire size that equipped the original Liberator still does the job. Lighter, U.S. Royal Rayons replaced heavier, bulkier cotton cords. And today, more "muscle," more strength to carry the thirty-ton load is built into new Nylon tires supplied in large quantity by "U.S." to the Army Air Force.

B-17 Boeing Flying Fortress—The very words, Flying Fortress, have become the symbol of deadly, long-range bombing power. The achievements of the Fortress and its heroic crews in precision bombing have earned it a distinguished place in the history of World War II.

In 1940, the rated gross weight of the Flying Fortress was 45,470 pounds. Today with thirteen heavy guns, with bullet-sealing fuel cells carrying long-range supplies of gas, with ten tons of bomb load, the Fortress weighs approximately 65,000 pounds—an increase of over 45%!

In 1940, the Fortress landed its 45,000 pounds on 19.00 x 23 tires. Today, with 65,000 pounds and more, the tire size has been increased only slightly. "U.S." tire engineers first built tires with rayon bodies as gross weight increased. They carried the load over rough landing fields at higher and higher speeds. Then came U.S. Royals with Nylon bodies delivering 64% more strength than rayon tires!

U.S. RUBBER COMPANY

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U. S. Royal Airplane Tires and Tubes Are Engineered for Today's Loads

U. S. ROYAL SMOOTH CONTOUR TAIL WHEEL TIRE—Like every U.S. Royal Airplane tire, the Tail Wheel Tire is available in Static Conductor Construction.

U. S. ROYAL SMOOTH CONTOUR BLOCK TREAD—The sharp edges of the U.S. Royal Block Tread protect against either forward or lateral skids.

U. S. ROYAL SMOOTH CONTOUR ICE GRIP
A radically new "bottle cap" tread design for unexcelled traction on snow and ice.

The U.S. Royal line is complete with tires and tubes for landing wheels, nose wheels and tail wheels. Static Conductor Construction is available in all types.

If you have not used U.S. Royal Static Conductor tires on your planes, write us for complete information today. Your nearest "U.S." Field Airplane Tire Engineer, whose time is spent exclusively on airplane tire and tube developments, will gladly work with you on this or any other airplane tire problem.

UNITED STATES RUBBER COMPANY

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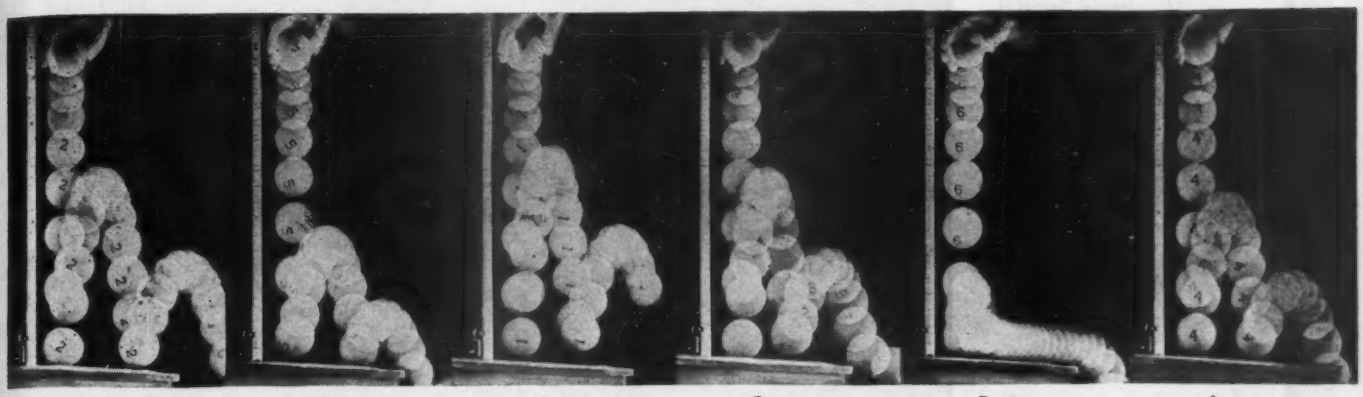
BOUNCE, BALLS, BOUNCE!



2 (Synthetic) 5 (Synthetic) 1 (Natural) 3 (Synthetic) 6 (Synthetic) 4 (Synthetic)

SIX SOLID BALLS OF RUBBER caught in the act of bouncing by a high-speed camera that shoots at the speed of 1/6592 of a second. All of them were dropped from exactly the same height...and yet, what a difference there is! One of the balls is made of a compound containing natural rubber. Each of the other five balls contains one of the five major types of synthetic rubber.

Can you pick out which of the balls is made of the rubber used in making Army barrage balloons? Which rubber is being used today for making tires for military and essential civilian cars? Which one is used for bullet-sealing gasoline hose? Which for insulating tape? Which for making lacquer hose? Try your skill. You will find the answers to these questions in the box at the bottom of this page.

SYNTHETIC RUBBER IS NOT JUST ONE NEW KIND OF RUBBER

It is a whole family of new materials each with its own important uses

Bounce the balls as much as you please. One bounces high. One bounces low. One bounces in between. Which one is best? Actually, there is no one "best kind" of rubber for every purpose. Without all of these main types of synthetic and natural rubber, it would be impossible to beat our enemies and bring our victorious men home as swiftly as possible.

The rubber industry, the chemical and petroleum industries, the Government, working as a team, have made this achievement possible. By pooling all their experience with synthetic rubber, their resources, their skill, they have broken the threat of "rubber shortage" the Axis counted on to throw us out of the war. More than that, they have produced types of synthetic rubber that can do special jobs better than they have ever been done before... and for all time declared our independence from any future cut-off of the nation's rubber supply.

That is the true meaning of the synthetic rubber program. We are proud to have contributed our experience and our resources to doing this job... and doing it in record-breaking, history-making time.

What the future holds for synthetic rubber is not yet fully known. Yet this much is certain. When the war is won, the knowledge we are gaining every day through the use of all these synthetic rubbers, alone and with natural rubber, will make peacetime products... whether tires for your car, belts for your factory, waterproof footwear for your children, or gasoline hose for your service station...better and more serviceable than they have ever been before.

THEY MAY LOOK LIKE "SIX OF A KIND" BUT HERE ARE THE ANSWERS TO THE WAR JOBS EACH ONE CAN DO

1. This ball was made with natural rubber...today used in limited quantities in combination with synthetics because of our small reserve stock.

2. Used for tires, conveyor belts, fire hose and many other products. It is most like natural rubber and can be quickly and efficiently processed.

3. Used for making solvent and lacquer hose and other products where the utmost resistance to solvents is needed...better than natural rubber for these purposes.

4. Used for making bullet-sealing fuel hose for planes and for other uses where high resistance to aromatic fuels is essential.

5. Used for coating barrage balloons, tank linings, packings, acid hose, wires and cables. This type does not support combustion and is highly resistant to sunlight and chemicals.

6. Used for insulating tape, molded parts. It is soft, pliable and odorless.

Listen to United States Rubber Company program, featuring New York Philharmonic Symphony Orchestra, Carl Van Doren, and a guest star, broadcast over Columbia network every Sunday afternoon 3:00 to 4:30 P. M. Eastern War Time

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  - Integral Fuel Tanks
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  - Intercoolers
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  - Seaplane Floats

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Our Engineering, Technical, and Laboratory facilities are at the service of any industry with a sealing problem.

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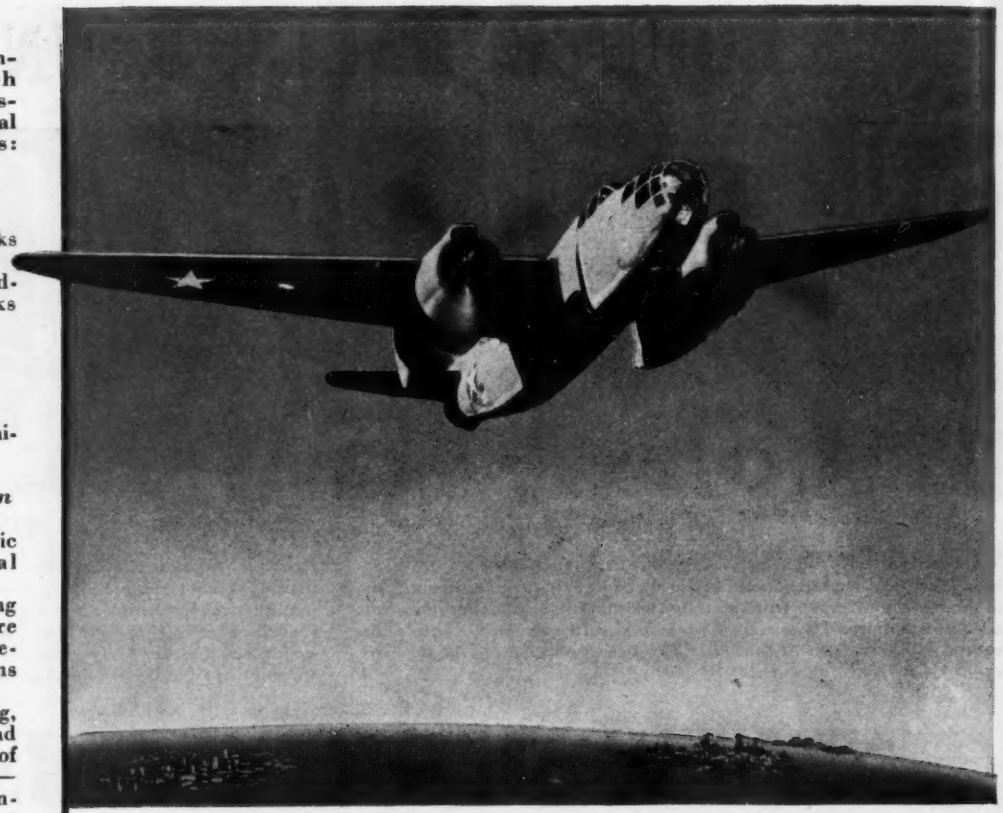

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Presstite Sealing Compounds are playing an important part in America's production of military and naval aircraft. Yet it was the vision of our research and engineering staffs, aided by years of previous industrial experience, that enabled Presstite to meet the emergency demands of the aircraft industry in time of war.

From sealers used by the refrigeration and construction industries, by the railroads, and in many other fields, Presstite engineers developed special sealing compounds that today speed the assembly and contribute to the safety and efficiency of America's air armada.

Not only are Presstite sealers being used to seal aircraft fuel tanks, fuselage seams, gun turrets, seaplane floats, pressurized cabins, and other vital parts and devices, but we are producing many special compounds for the U. S. Ordnance Department, the Engineers Corps, and the U. S. Navy.

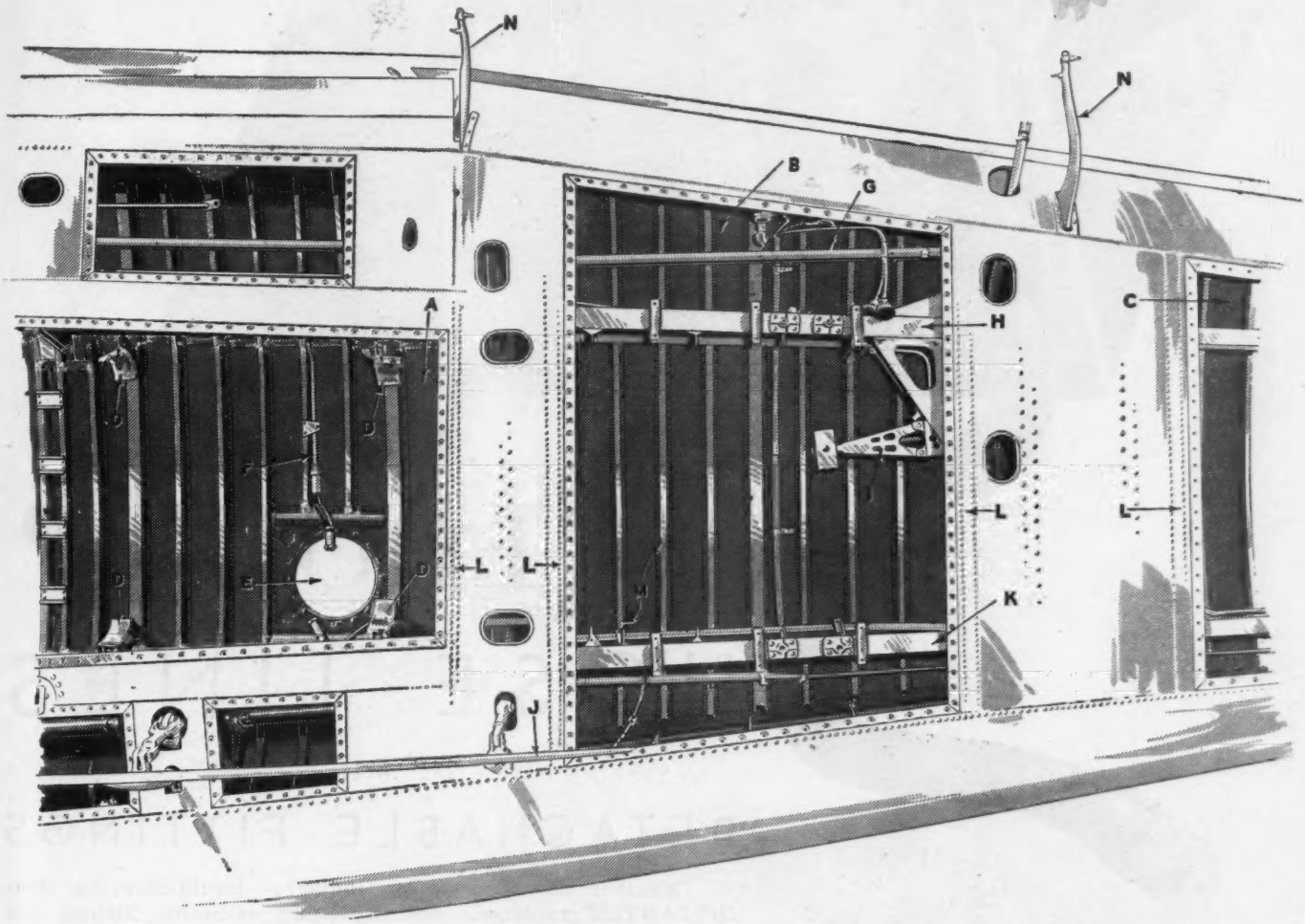
"*Ceiling Unlimited*" is the pilot's signal that the far horizons of the sky are visible in every direction. "*Vision Unlimited*" is symbolic of the continuing forward progress of Presstite engineering and research.

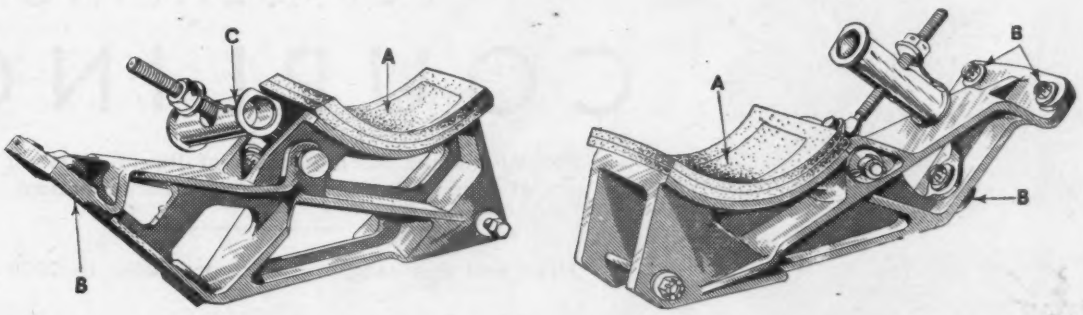
Today, and in tomorrow's post-war era, the vision unlimited of the Presstite organization stands ready to serve American industry wherever the most effective sealing compounds are required. We'll gladly work with you and your engineers, if you'll send us your detailed requirements.

PRESSTITE ENGINEERING COMPANY, 3910 Chouteau Avenue, St. Louis, Missouri

SKETCH BOOK OF DESIGN DETAIL

Underside of JU-88 main wing panel, with three inspection panels at *A*, *B* and *C* removed. One wing gas tank fits in section *A*, supported by four fittings *D* (shown in detail in sketch below). Gas tank ports fit in hole *E*, with fuel flowing through line *F* from tank to engine. Aileron torque tube *G* is located behind rear spar *H*. Bell crank system counter balance is at *I* and dive brake *J* (shown in extended position) is located ahead of front spar *K*. Main drag ribs of this section are at *L*, between which are "U" sections as shown at *M*. Aileron support arms are at *N*.





Details of JU-88 wing gas tank supports, shown at *D* in sketch at top. Direct contact between tank and support is avoided by synthetic rubber pieces *A*. Attachment to front and rear spar is by bolts at points *B*, and tank itself is held on bracket by strap attached to clamp *C*. Strap attaches to front and rear bracket, going over top of gas tank.

WHERE TIME COUNTS

North American P-51 Mustang

SPECIFY

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HOSE LINES

WITH

DETACHABLE FITTINGS

Whether for aircraft or industry—liquid-carrying lines INSTANTLY replaced, with Aeroquip re-usable fittings and hose lines "tailored" on the spot.

SELF SEALING

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Permit instant disconnection of liquid-carrying lines without loss of fluid or inclusion of air on reconnection.

High and low temperatures; pressures to 2000 lbs.

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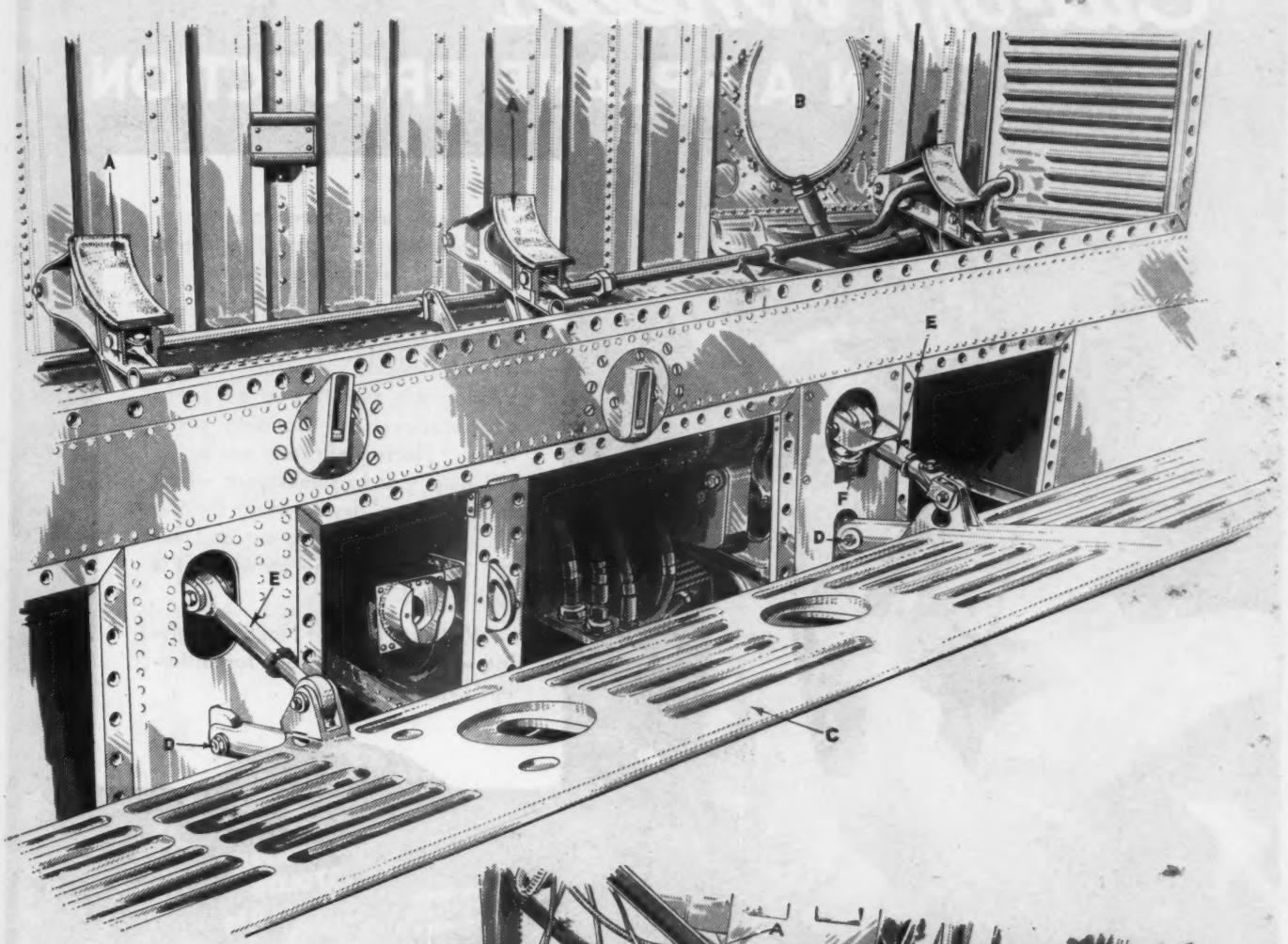
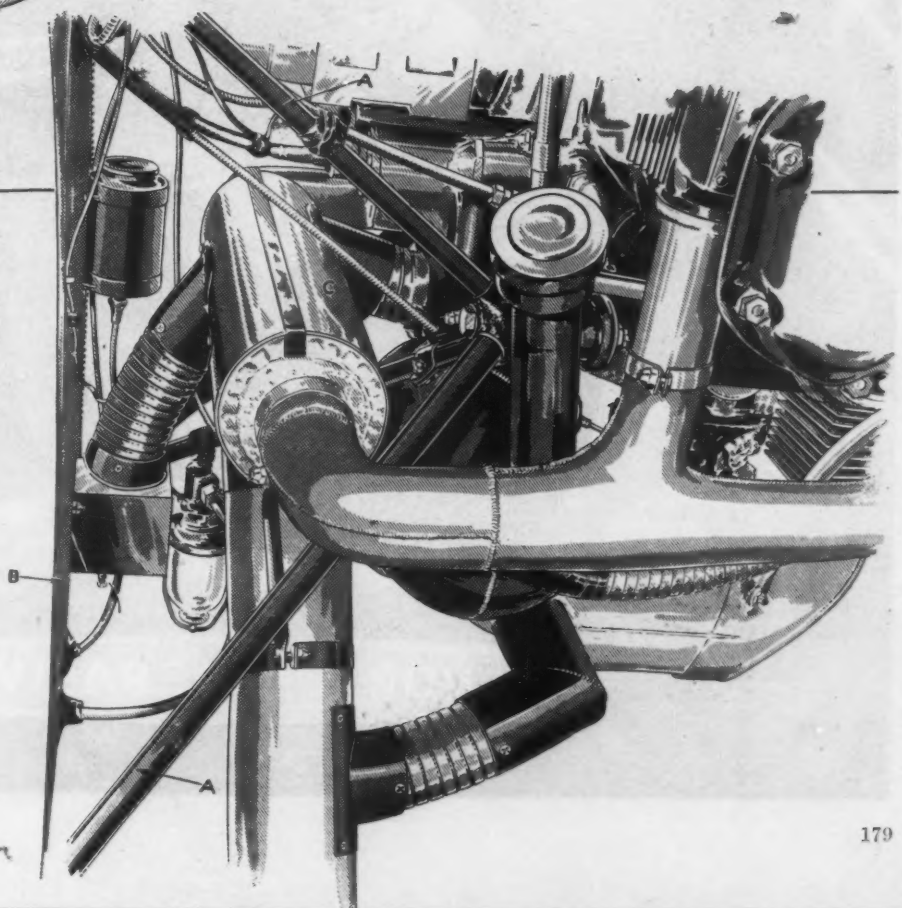
Underside view of part of JU-88 wing panel with leading edge down, shows front wing gas tank brackets at *A*. Tank fits so that filler port goes into hole *B*. Dive flap *C*, shown in extended position, hinges at points *D*. Flap movement is accomplished through torque tubes *E* operated by hydraulic cylinders located within wing at *F*.





Stainless steel muffler, standard equipment on Piper *Coupe*, is fitted to engine between tubular structure of engine mount *A* and firewall *B*. Stove *C* around muffler supplies warm air to cabin.

NORTON *Cut-off Wheels* IN AIRPLANE PRODUCTION

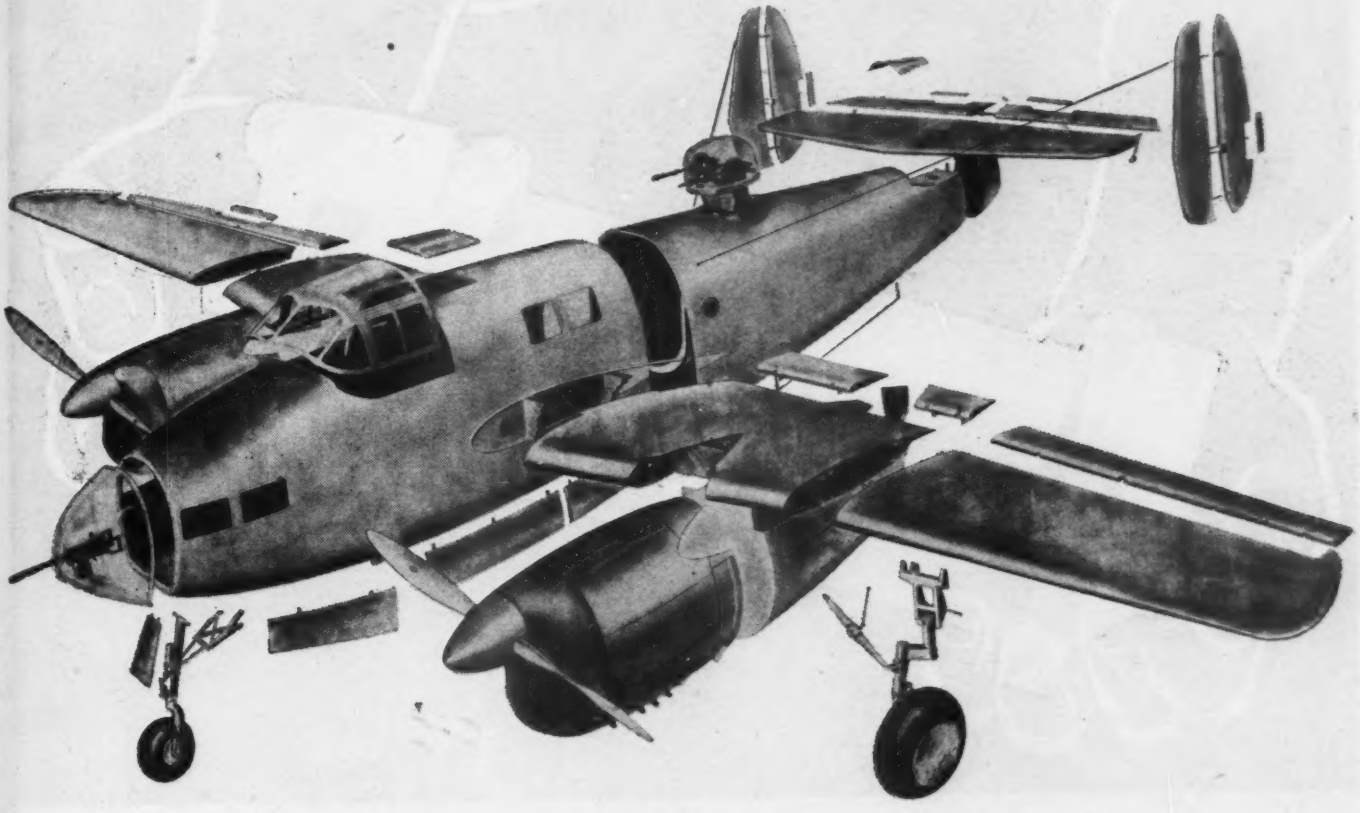
In each great bomber pioneering the skies to Victory, hundreds of feet of tubing are used.

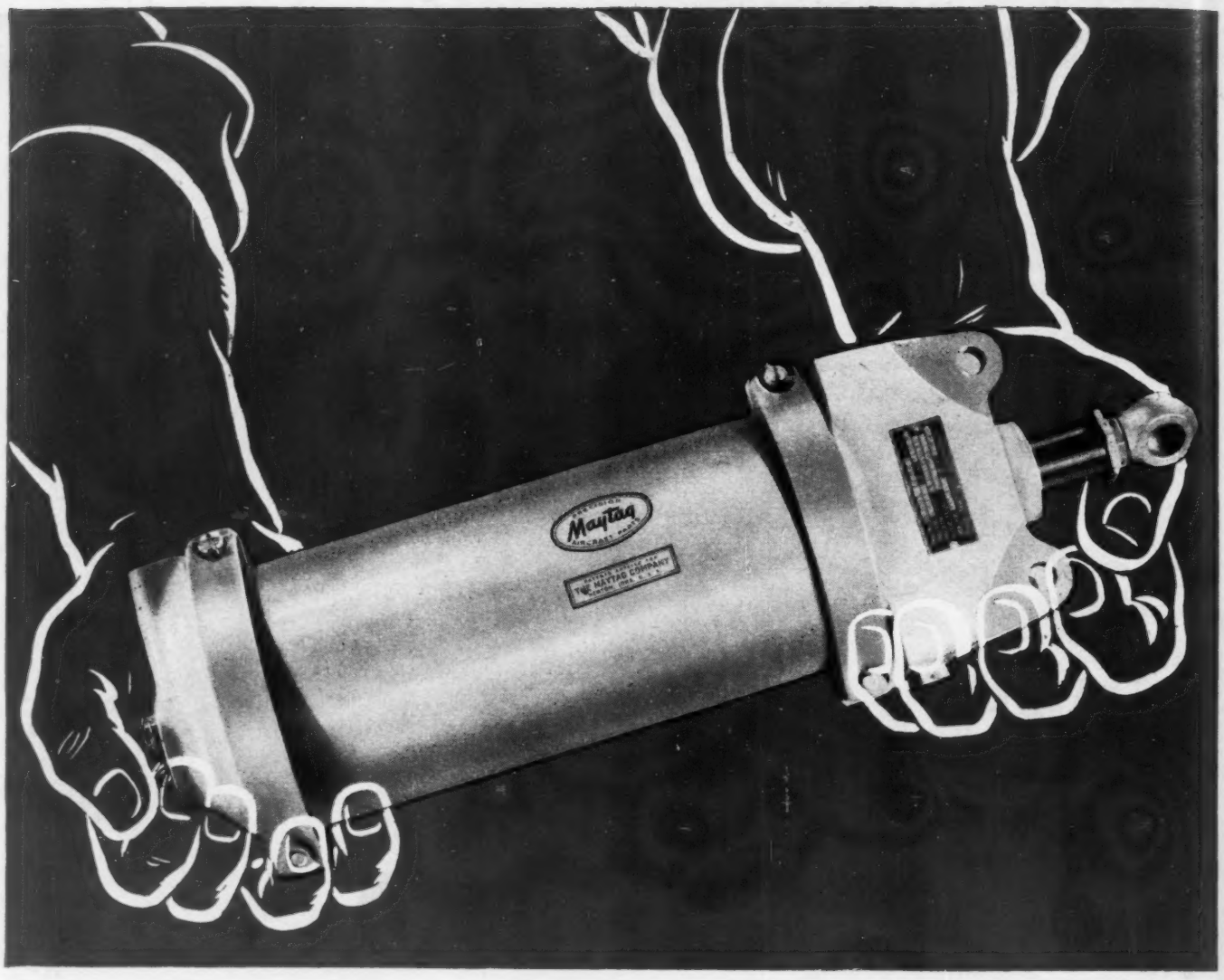
Cutting off tubing is an important and sizeable operation in every aircraft plant. Norton Cut-off Wheels are available in a variety of abrasives and bonding processes. Norton abrasive engineers will help you to select your wheel for "wet" or "dry" cutting for the kind of tubing to be cut and for the type of machine on which it is to be used.

Write for booklet No. 517A giving wheel specifications for different kinds of tubing.

NORTON ABRASIVES

Exploded views of Fairchild AT-21 *Gunner*, four to six place crew trainer, now in volume production for AAF. Powered by two V-12, air-cooled Ranger engines developing 520 hp. each at takeoff, *Gunner* has top speed of 235 mph. and cruising speed of 198 at 5,000 ft. Fuselage is full monocoque aft of center section, with forward portion supported internally by welded steel tube truss. Wings are two-spar wood construction with wood ribs. Fuselage and wing covering are of plastic bonded veneers, molded to shape by Fairchild-developed Duramold process. Lower sketch shows exploded view of production subassemblies of Duramold.





Maytag Hydraulic Cylinders Feature Rugged Simplicity

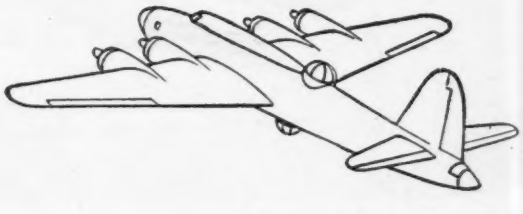
THE CYLINDER illustrated is being used today on a famous American bomber.
Its rugged simplicity is typical of Maytag hydraulics . . . a simplicity resulting in lighter weight . . . fewer parts . . . and greater dependability. Maytag hydraulic cylinders are different. They incorporate distinctly unique principles of construction Maytag is proud of the significant contributions of its engineers in the field of hydraulics.

Maytag also produces Eclipse electric retracting units . . . aluminum alloy aircraft castings.

THE MAYTAG COMPANY, NEWTON, IOWA

Maytag

WASHERS IRONERS



Mechanical Properties Of Plexiglas

SCRATCH RESISTANCE of Plexiglas is measured by several methods.

1. *Moh's Scale,* which uses the resistance of various minerals to scratching as a basis for comparison. Talc—with the least resistance—is No. 1, followed by other materials with gradually increasing hardness up to the diamond, which is No. 10. The Moh's number for Plexiglas is from 2 to 3, being equal to rocksalt or calcite.

2. *Bierbaum Number* is obtained by measuring the width of a scratch made on surface of material by a diamond cut to shape of a cube and mounted so that diagonal of cube is perpendicular to surface to be tested, while edge of cube is in line with scratch. The Bierbaum number is obtained by dividing load on diamond in kg. by width of scratch in mm. Bierbaum number for Plexiglas is 15 to 18.

3. *Pencil hardness* is used to indicate scratch resistance. Plexiglas resists scratching by pencils of less hardness than 8H. and by alloy pencils softer than 30 percent antimony—70 percent lead.

Brinell Number is from 18 to 20, using 500 kg. load and 10 mm. ball.

Rockwell Number is M70, using 100 kg. load and $\frac{1}{4}$ in. ball. Both of above hardness tests made at 77 deg. F on $\frac{1}{8}$ in. stock.

Rebound is measured by means of Shore Scleroscope, which tests material by dropping a diamond pointed weight or steel ball on a rigidly supported specimen. Height of first rebound gives rebound rating. Using diamond point, Plexiglas rating is *80/140,* while with a $\frac{1}{4}$ in steel ball reading is *75 percent.* Both of these tests were made on a sample $\frac{1}{4}$ in. thick at 77 deg. F. This test is of value in comparing resistance of plastics to repeated light impacts.

Abrasion Resistance is measured by the Rohm & Haas test, which was developed by the manufacturers in the absence of any effective recognized test for this quality Test is made by pouring a free-falling stream of carborundum powder on surface, then measuring light diffusion on a haze meter. Plexiglas shows an increase of 40 percent on light diffusion after 200 gr. of No. 40 carborundum powder have been allowed to flow onto surface from a height of 2 in. at an angle of 45 deg. to the material

Impact Strength is measured at 77 deg. F. and is from *3 to 4 ft.-lb.* for a standard $\frac{1}{2} \times \frac{1}{2}$ bar. In this test a pendulum of given weight and radius is allowed to drop through a given arc to break the sample being tested. Arc through which pendulum travels after breaking sample gives residual energy which is subtracted from energy of pendulum to give force required to break material. Impact strength of Plexiglas is affected very little by changes in temperature. Thickness affects impact strength approximately as square of thickness, area being unchanged. Large areas naturally are able to withstand higher impacts than smaller ones, due to greater resilience of surfaces. Shape is an important factor in strength of Plexiglas objects, as may be seen from following results: Using $\frac{1}{4}$ in. thick material, impact strength of a $13\frac{1}{2}$ in. dia. flat disk was 9 lb.; that of a 12 in. × 12 in. flat square was 10 lb.; a $13\frac{1}{2}$ in. dia. 24 in. radius spherical section was 8 lb. and a 12 in. × 12 in. cylinder, 24 in. radius was 14 lb.

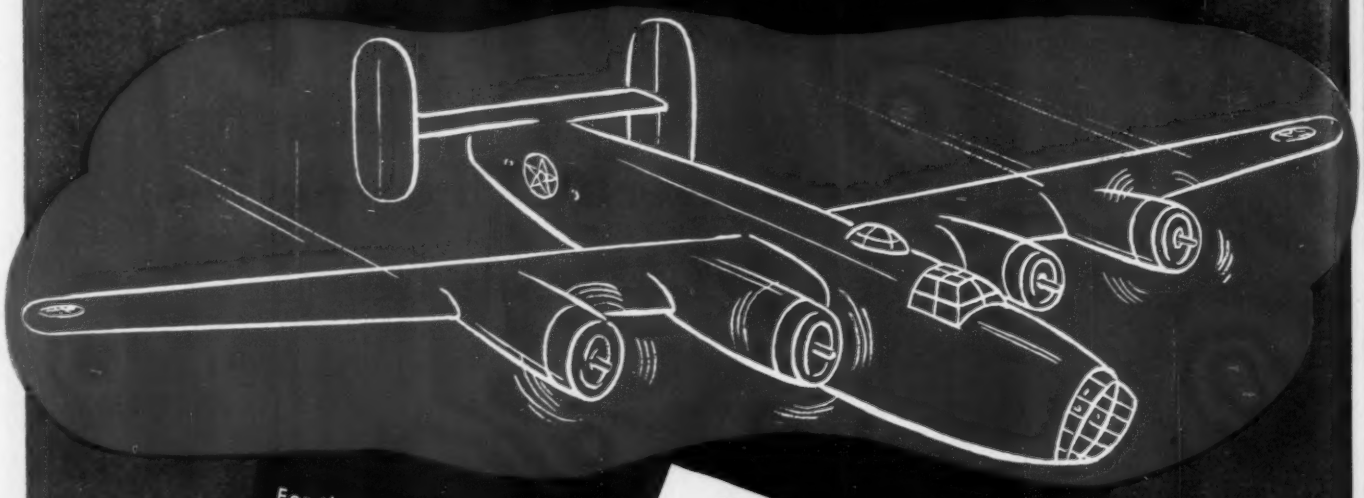
It is obvious that impact energies have to be absorbed at entirely different rates, even though load may be same in ft.-lb. Table I gives results of tests made with bullets of various calibers, standard falling ball tests, and bag-of-shot test which is used in laminated glass industry. In latter test, a bag of shot, weighing 11 lb. is dropped from increasingly greater heights until sample is cracked.

Table I

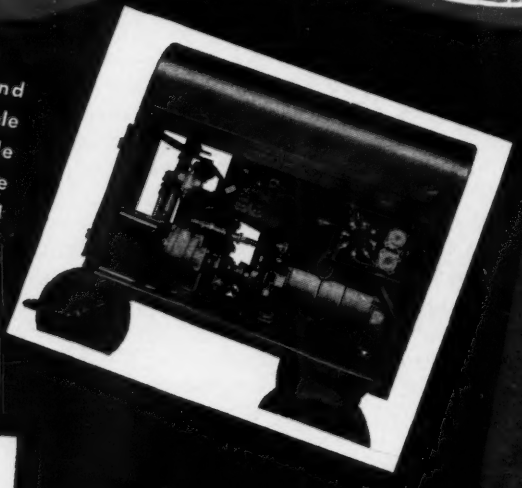
Thickness Inches	Bullet Impact	Falling Ball	Bag of Shot
060	.....	1.5 ft.-lb.	33 ft. lb.
.125	13 ft.-lb.	3.7 ft.-lb.	78 ft.-lb.
250	24 ft -lb.	9.5 ft -lb	217 ft.-lb
375	. . . . .	23 ft -lb.	.....
500	55 ft.-lb.	. . . . .	.. ..
1 000	168 ft.-lb.	. . . .	. . . . ..

Strength of Plexiglas samples is greatly affected by condition of surface, particularly that portion in tension. Data in accompanying Table II were obtained by means of Charpy tests using a falling pendulum on bars cut from

Exclusively LELAND

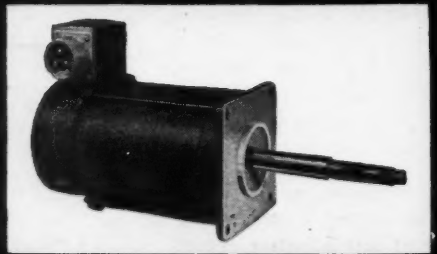


For the air services Leland developed, and are the sole builders of, the adjustable speed AC-DC motor on the accompanying truck. It is used to power aeroplane instrument testing equipment—driving a hydraulic pump to produce pressure—can be found at all air bases where power is available.



Also developed for the air services by Leland and being built exclusively by Leland, is the accompanying aircraft power inverter. This unit finds its application on planes where it furnishes high frequency alternating current to power automatic pilots, radio compasses and other electronic devices in aviation.

The third Leland unit here shown is an aircraft type DC motor used to operate landing gears.



Leland engineering and Leland plant facilities are geared for war production and you, perhaps, may find at Leland the solution of some design or supply problem now troubling you.

Leland

WAR DUTY MOTORS

THE LELAND ELECTRIC COMPANY, • DAYTON, OHIO

Mechanical Properties Of Plexiglas

stock .500 in. thick. The finish of samples was as indicated in left hand column.

Table II

Condition of Tension Surface	Charpy Impact Strength, Ft.-Lb.	Maximum Flexural Strength, Psi.
A. Polished to remove scratches	3.2	13,750
B. Sawed	2.9	13,600
C. Passed through planer so that scratches are parallel to long dimensions	3.4	13,400
D. Passed through planer so that scratches are perpendicular to long dimensions	3.1	13,300
E. Sanded on belt sander so that scratches are all parallel to long dimension	3.5	13,500
F Sanded on belt sander so that scratches are all at 45 deg. angle to long dimension	3.0	12,800
G. Sanded on belt sander so that scratches are perpendicular to long dimension	1.6	9,530
H. Tension side sanded so that scratches are parallel to long dimensions, compression side sanded so that scratches are perpendicular to long dimension	3.2	13,000
I Tension side sanded perpendicular, compression side sanded parallel to long dimension	1.6	9,300
J. Sanded on belt sander so that scratches were perpendicular to long dimension, then resanded so that scratches are parallel to long dimension	3.3	13,100
K. Sanded on belt sander so that scratches are perpendicular to long dimension, then coated with one heavy coat ethylene dichloride-Plexiglas solution	2.2	13,000
L Same as K except two medium coats ethylene dichloride-Plexiglas	2.9	13,000

Tensile Strength is determined from a sample ½ in. wide, filed and sanded to a smooth but not polished surface. Dots are inked on surface 2 in. apart to measure elongation of sample. At room temperature, elongation varies with stress until a point between 6,000 and 7,000 psi. is reached, after which it rises until reaching 7,500 psi. point, when elongation is about 4 percent. Beyond this, resistance to stretching drops off until it may be as low as 5,500 psi. at breaking point, though in some cases it has been as high as 7,000.

Temperature affects tensile strength inversely as the amount of heat applied. Starting with a T.S. of about 9,500 psi. at 14 deg. F., strength decreases in approximately a straight line until it reaches 3,500 psi. at 104 deg. F., elongation in latter case being nearly 150 percent. Rate of straining in this test is .050 in. per min.

Age and Conditioning do not affect T.S. of Plexiglas to any appreciable extent, except that complete dehydration causes strength to rise about 10 percent. Seemingly the greater elongation of moist specimens is due to a lubricating effect in material.

Rate of Straining may cause as much as 1,700 psi. in max. T.S. with a corresponding effect on elongation. Tests made at from .050 in. per min. to .400 in. per min. show a decided increase in T.S. at higher figure.

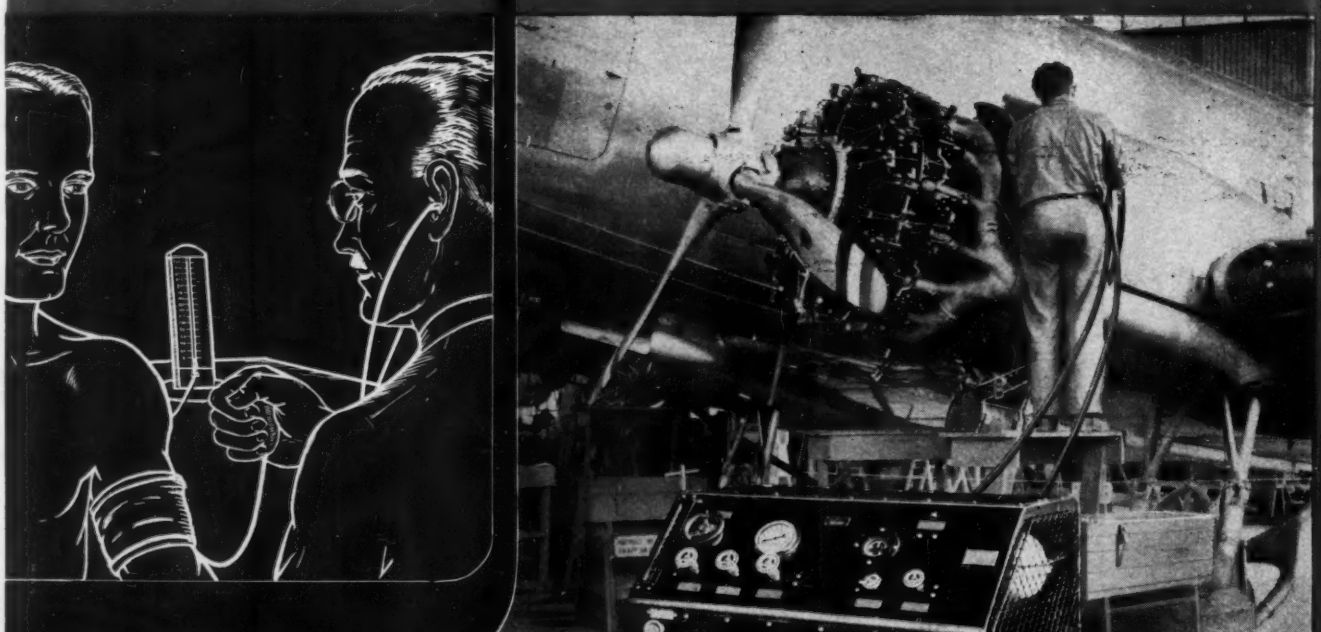
Pre-stretching sets up a grain in Plexiglas causing polymer chains formed in manufacture to fall into parallel lines. Test pieces 1½ in. × 12 in. were stretched to 10, 25, 50, 75 and 100 percent of their original length and specimens cut from them with their long axes in direction of stretch. Plates 8 in. × 10 in. were also stretched to 10 and 25 percent of their original length and test pieces cut perpendicular to direction of stretch. Mechanical difficulties prevented further stretching of sheets. Results are shown in accompanying Table III.

Table III

Stretching, Percent		Average Maximum Tensile Strength, Psi.	Average Elongation at Failures Percent	Average Stress at Failures Psi.
None		7,530	20	5,730
Longitudinal	10	7,620	20	6,080
	25	7,780	35	6,130
	50	7,750	60	6,600
	75	8,000	60	7,710
	100	8,080	60	8,060
Transverse	10	8,120	1.3	8,050
	25	7,970	1.2	7,970

Above data supplied by Rohm & Haas Co.

Sphygmomanometer



it tests the "BLOOD PRESSURE" of airplanes

Your doctor uses a sphygmomanometer when he checks your blood pressure . . .

Similarly, the test stand in the photo above is what the ground crew uses to check a plane's hydraulic system—the system that furnishes power for swift, foolproof control of ailerons, elevators, rudders, bomb-bay doors, landing gear, propeller-feathering mechanism, wing flaps and brakes.

A pump at the plane's motor is the "heart" of this hydraulic system. To make a test, connections from pump to system are switched to the HydrOILic test stand, the circuit is completed by starting the tester, and the plane's hydraulic system is quickly checked at test pressures.

In addition to hydraulic circuit testers, Denison builds many other test stands for checking the *flight* performance of aircraft *on the ground!* There's a HydrOILic unit that checks aircraft spark plugs. Another tests magnetos. A third tests the feathering action of propellers—and there are still others.

* * *

You'll also find HydrOILic equipment used in the production and assembly of airplane parts . . . and used in the airplanes themselves. HydrOILic valves, cylinders, motors and pumps are built into many types and makes of production machinery in all industry.

Denison HydrOILic engineers have proved their unusual ability to get better answers to all sorts of production, testing, and movement-control problems. This, added to the exceptional *accuracy* and *flexibility* of fluid (oil hydraulic) power transmission, is the reason for the wide use of HydrOILic equipment. Denison may already have the answer to your own problems, or perhaps know a short cut to the best solution. Your inquiry will bring the desired information. Please write. The DENISON Engineering Company, 1166 Dublin Road, Columbus 16, Ohio.

HydrOILics FOR POWER, SPEED and CONTROL

Industry's Right Hand

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EQUIPMENT *in* APPLIED
HydrOILics
TRADE MARK

WILCOX EQUIPMENT

used by major Airlines throughout the United States

Proof of quality and dependability is in performance. Wilcox radio equipment is installed on major Commercial airlines throughout America, and in addition it is being used throughout the entire world in connection with military operations. For airline radio communications, depend on Wilcox!

WILCOX ELECTRIC COMPANY

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Another Finer Feature of Logan Lathes

The accuracy you need for precision work is yours in a Logan Lathe, even after long continuous use. For Logan combines solid strength and Nth degree accuracy in every Logan Lathe bed. Extra heavy ribbed and warp-free, the Logan bed is machined from the finest special analysis castings obtainable. Its V ways and flat ways are precision ground to an accuracy of within .001 of an inch from end to end. This fine construction, usually found only in the highest priced lathes, is another reason why alert production men are depending more and more on Logan Lathes for low cost production of small parts.

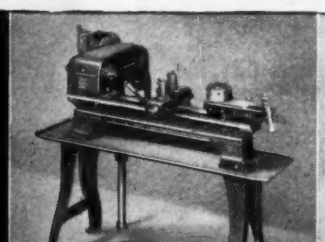
Write today for catalog sheets giving complete specifications on all models of Logan Lathes... Quick Change Gear Types... Manufacturing Turret Lathes... Hand Screw Machines... Floor Model Back Geared Screw Cutting Lathes... Bench Model Back Geared Screw Cutting Lathes.

LOGAN ENGINEERING COMPANY
Chicago, Illinois

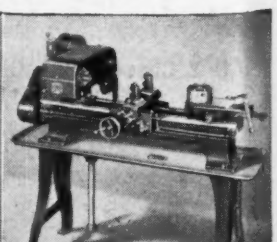
BRIEF SPECIFICATIONS

Swing over bed, 10½"... bed length, 43⅛"... spindle hole, 25/32"... capacity, ⅝" with push type collet... 6-position automatic indexing turret ... stroke of turret, 4¼"... 12 spindle speeds from 30 to 1450 r.p.m.... all moving parts protected by ball bearings or self lubricating bronze bearings.

Logan ... A NAME TO REMEMBER WHEN YOU THINK OF LATHES



No. 830—⅝" Capacity Hand Screw Machine



No. 850—Manufacturing Turret Lathe

Review of Patents

By A. HARRY CROWELL,
Registered Patent Lawyer

FOLLOWING are digests of some of the more significant recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will be glad to furnish readers information, without charge or obligation, on approximate cost and procedure in applying for patents and trademark registrations. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York 18. Printed copies of any of the patents listed below are obtainable at 10c. each directly from U. S. Patent Office, Washington.

Landing Gear Device. Improvement indicated here is linkage arrangement which in the retraction and extension of the undercarriage acts to keep a uniform loading on the gear's actuator. This is stated to be accomplished by designing linkage so that angles between links are kept between two extremes instead of reaching a stall or dead point.—2,323,385, filed Oct. 2, 1940, patented July 6, 1943, E. A. Eddy, assigned to Brewster Aeronautical Corp.

Rotative Wing Aircraft. This is direct takeoff autogiro in which rotor blade is driven during takeoff but is auto-rotated after takeoff. An interlocked control system is designed to release wheel brakes, disconnect rotor drive, and set pitch of rotor blades to "lift" all simultaneously. System is of electro-hydraulic type.—2,324,588, filed Oct. 31, '41, patented July 20, '43, A. E. Larson, assigned to Autogiro Co. of America.

Auto-Control System. Patent is for improved control of aircraft using automatic pilot system, specifically to overcome tendency of over-controlling. Gyroscopes have been added to damp over-control action and make for more precision in controlled movements of plane.—2,325,108, filed Apr. 16, '42, patented July 27, '43, B. G. Carlson, assigned to Jack & Heintz, Inc.

Rudder and Flap Control device is for control system where rudder has flap to assist movement. Normally locked in alignment with rudder, flap will not flutter at low speeds. System is designed to move flap with first movement of rudder control before rudder itself moves while at same time preventing movement of flap by slipstream.—2,325,548, filed Dec. 7, '40, patented July 27, '43, H. Roos et al, vested in Alien Property Custodian.

New Glider Launching Mechanism comprises power unit shaped like a bomb and using jet propulsion. Unit is slung between undercarriage wheels in same manner as a bomb. When glider is airborne, unit detaches, ready for use on other gliders.—2,325,630, filed Sept. 1, '42, patented Aug. 3, '43, J. N. Petty.

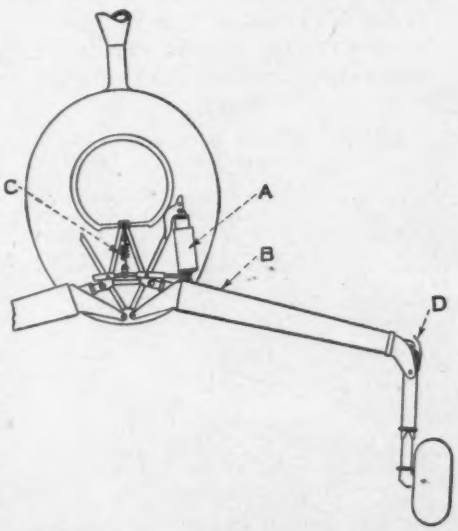
Rotary Wing Craft Design calls for rotor with variable pitch blades wherein blades are controlled automatically by stresses acting thereupon. When rotor speed increases, pitch increases; conversely when rotor speed decreases pitch decreases.—2,325,632, filed Jan. 30, '40, patented Aug. 3, '43, C. G. Pullin, assigned to Autogiro Co. of America.

Airplane Fabric Assembly. Patent relates to wing framework construction, particularly to system for retaining fabric on wing. Frame is of tubular members with outer portion of each exterior tube slotted to receive wing fabric. Rod inserted in loop of fabric within tube clamps fabric in slot.—2,325,900, filed Jan. 2, '42, patented Aug. 3, '43. J. K. Anderson.

Endless-Track Undercarriage is designed to replace normal wheel and tire arrangement to increase effective load supporting area without materially augmenting bulk of landing element. It is constructed for both retraction and steering.—2,326,019, filed Oct. 12, '39, patented Aug. 3, '43, G. H. Dowty.

Modifications of preceding device concern retraction arrangements in which endless track member retracts (1) upright or (2) sidewise, in both cases so that undersurface comes in flush with lower wing surface.—2,326,020, filed Nov. 25, '39, patented Aug. 3, '43, G. H. Dowty.

Multi-Drive Plane. Here, patent is for craft with multiple propellers which are belt driven from a single power plant. Further provided is longitudinal adjustment of engine to assist in trimming plane during flight.—2,326,104, filed Mar. 26,'41, patented Aug. 3, '43, J. Petrich.



Monocoque-strut landing gear for autogiros, covered in patent awarded to A. C. Falk and R. A. Wagner, provides high vertical travel by means of oleo shock absorber *A*, push-pull rod *B* containing thrust bearing, adjustable tension spring *C*, and knee-like joint *D*. Filed Mar. 14, '41, patented Aug. 10, '43, and designated No. 2,326,210, this device is assigned to Kellet Aircraft Corp.

Multiple Chuting of Equipment. Container arrangement is designed to allow simultaneous launching of equipment parachutes, followed by their separation in the air so there is no tangling. Packs are connected by means of straps running from bottom of one pack to rip cord of parachute of one below, with rip cord of initial pack hooked to static line of plane. Static line opens chute of first pack, which in falling opens chute of second pack, action then continuing through remaining packs.—2,326,813, filed Apr. 18, '42, patented Aug. 17, '43, H. Wilson.

Flying-Wing Plane Design has contra-rotating propellers of pusher type at rear of short fuselage. Rudder and normal tail surfaces are located on short booms extending rearward from tips of wings.—2,326,819, filed Aug. 28, '40, patented Aug. 17, '43, D. R. Berlin, assigned to Curtiss-Wright Corp.

De-Icer Apparatus comprises elastic boot which can be inflated with 10 lb. pressure for common ice removal or higher pressures for glaze ice. Boot has multiple passages for low-pressure inflation, larger passage for higher pressure.—2,327,034, filed Sept. 30, '41, patented Aug. 17, '43, W. G. Geer.

Auto-Pilot Device is designed as improvement on automatic control of earlier patent (No. 2,325,108, July 27, '43). Chief difference is arrangement of oil-operated gyro which permits gyro's movement to control flow of its propelling oil.—2,327,171, filed Apr. 13, '42, patented Aug. 17, '43, B. G. Carlson, assigned to Jack & Heintz, Inc.

Variable Form Parachute Pack is constructed with elastic fabric so pack will conform to wearer's shape. Fabric's degree of elasticity is controlled to restrain deformation of pack.—2,327,358, filed Sept. 5, '41, patented Aug. 24, '43, F. G. Manson, et al.

Crash Indicator is device upon which pilot can specify difficulties occurring in his plane when it is about to crash. Device would be expelled from plane and drop by chute to indicate conditions leading to crash.—2,328,208, filed May 6, '41, patented Aug. 31, '43, E. G. Friedman.

Aerostation Safety Valve. This is valve to control gas cells of lighter-than-air craft. It is designed to regulate pressures in gas bag by valving off gas whenever pressures within bag reach predetermined maximum.—2,329,002, filed Apr. 26, '41, patented Sept. 7, '43, E. Schoettel.

(*Turn to page* 293)

Where Are Those Dividends?

By H. L. FEDERMAN

Paucity of cash-per-share returns may puzzle the questioning layman, but a check of the aircraft industry's financial history quickly shows there's no mystery about it.

DESPITE established success in earnings, the aviation industry has done very poorly in rewarding its stockholders with cash dividends. This is demonstrated by the record of both the aircraft manufacturing group and the air transport operators.

While this condition may be disappointing, it is characteristic of all new and growing enterprises. For example, an examination of the dividend record of the radio industry shows no disposition to make liberal disbursements. Radio has been in the ascendancy for more than a decade, yet has made meager dividend payments despite its outstanding success. New developments required constant refinement and provision for mounting contingencies, and the economic uncertainties of the times have introduced a cautionary note in all forms of industrial life so that even the highly successful corporations of stable and mature record have had a tendency to go easy on dividend payments.

It is ironic, however, that the aircraft industry, with its risky beginnings, and the hope of liberal dividend payments if successful, is unable to fulfill this expectation largely due to conditions beyond its control.

The threads of aircraft industry financial history show a definite pattern always weaving its way—a pattern tending to slow up dividends. It is not so long since aircraft builders were pioneering and had all they could do to survive, let alone return a profit on the investment. No sooner had this uncertain period been hurdled when the need for more capital became apparent. This meant small dividend payments—if any. Subsequently, despite mounting earnings, much uncertainty disturbed the industry, "contingency" reserves became the order of the day, and dividends remained secondary. Then taxes and contract renegotiations bewildered managements and made liberal dividend payments unwise, and currently the industry is concerned about the postwar period, hence is interested in establishing reserves for reconversion and future developments. Certainly, dividend disbursements can hardly be encouraged by this sequence of events.

Typical comments of the times substantiate this pattern. The Aviation Corp. experienced one of the sharpest earnings gain in its history for the six months ended May 31, 1942. However, the company deferred action on dividend payments until a "reasonable forecast of earnings could be made." The reasons cited were: Uncertainties of selling prices of products, proposals for price ceilings on materials supplied by prime and subcontractors, and efforts toward wage stabilization in the industry.

Recently, Lockheed attributed its inability to establish a definite dividend policy to "working capital requirements and renegotiation of contracts." It isn't too difficult to find similar official expressions by other aircraft companies evidencing a strong inclination to husband resources in one form or another.

The most effective portrayal of dividend payments for the aircraft industry is the record itself. Table I discloses this earnings and dividend history for the last three years, as reported by the major companies. (Estimated earnings for 1943 are not available, thus the period 1940-1942 inclusive is used). It was during this period that the group enjoyed its most successful results. Included in the dividend payments shown are those paid or declared during 1943. While this may distort comparative results somewhat, it is fair to do so, since dividend policies frequently are established with a backward glance at the previous year's results. A lag of one year is nevertheless present and must be recognized.

It can be seen that the best dividend record among the group is enjoyed by United Aircraft. In this case, for a proper perspective, it may be well to go back to 1936 when the company made its first dividend disbursement, 50c. per common share. Since that time, the company has steadily increased the amount of its annual dividends until it hit a peak of $4 per share during 1941. For 1942, $3 was paid and thus far this year, $1.50.

It is believed likely that the company will pay another $1.50 before the year is over. With this assumption, and assuming further that the company will earn at least the same amount in 1943 as it did last year, aggregate earnings for the eight years ending with 1943 will total $31.94 per share of which $16.75 will have been paid to stockholders. This is not a bad record and can be particularly gratifying to any stockholder who bought shares at $10 back in 1935—and retained such holdings throughout the years. By the same token, any stockholder who paid more than $50 per share during 1940 would be very unhappy.

United Aircraft also has the distinction of having a preferred stock outstanding which has attained a high investment rating despite being identified with a highly speculative industry. Issued in Jan. 1942 slightly below par ($100 per share) this preferred stock subsequently sold in the low 90's but recovered rapidly to hit 114½ this year. Currently, this issue is selling around $106 per share. Carrying a 5 percent dividend rate, it is considered an attractive income producer. Earnings coverage was $65.74 per share for 1942 and will likely be larger this year. As it is convertible into the common stock at the rate of one common for each $40 of preferred, a hedge in the rise of the junior equity is also present.

In this connection, there are a number of other senior aircraft equities

(*Turn to page* 252)

TABLE I—EARNINGS AND DIVIDEND PAYMENTS OF MAJOR AIRCRAFT COMPANIES DURING LAST THREE YEARS.

(Source: Standard & Poor's Aircraft Industry Survey)

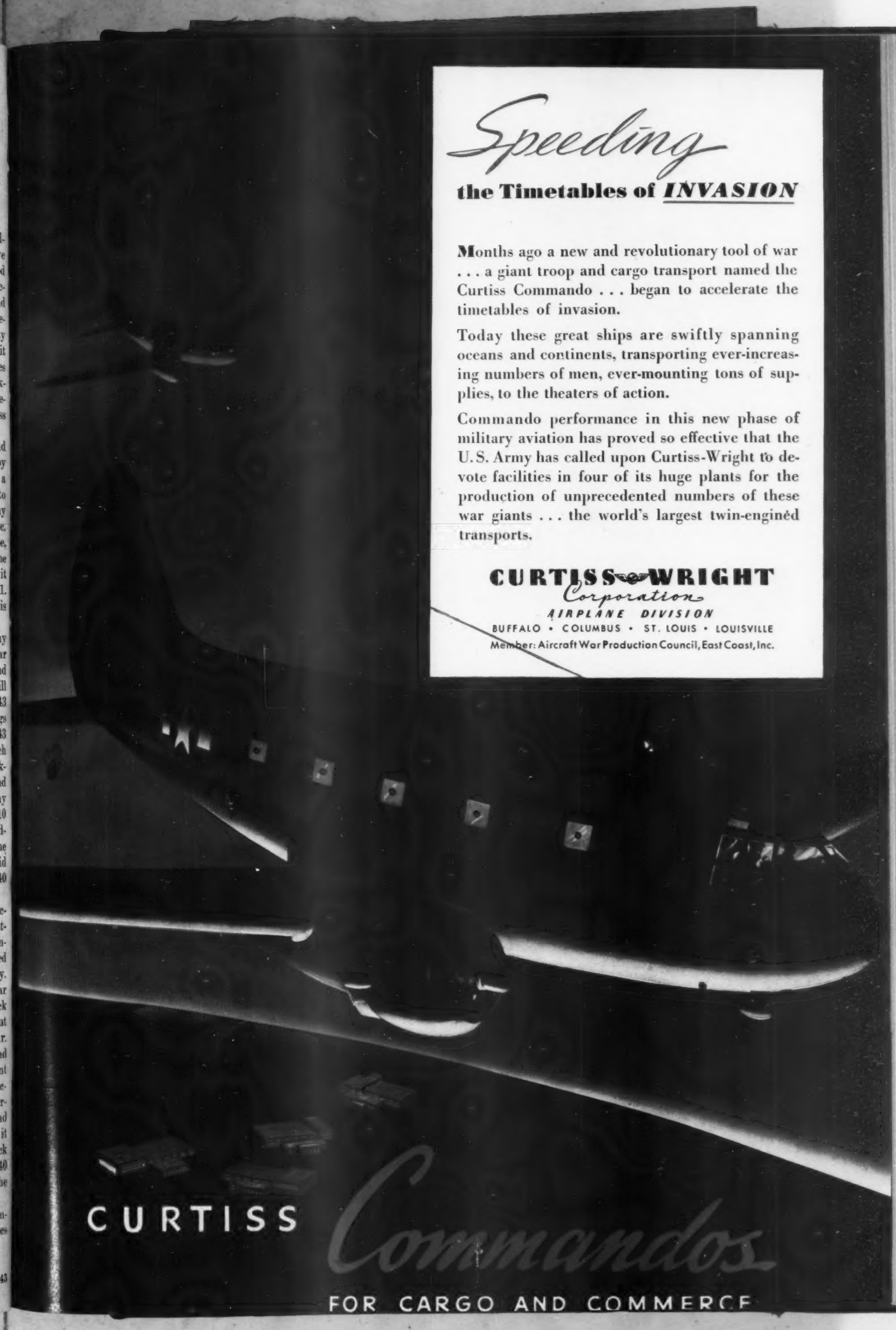
	Earnings Per Share*	Dividends Paid Per Share†
Aviation Corp.	$1.26	$ .50
Beech	7.39	1.00
Boeing	10.84	2.00
Bell	18.47	5.00
Consolidate - Vultee (common)	19.47	1.00
Curtiss - Wright (common)	6.41	2.50
Douglas	56.76	20.00
Grumman	9.33	4.25
Lockheed	18.01	6.50
Martin	16.20	8.00
North American	6.87	4.25
Republic	2.55	0.25
United Aircraft	18.09	12.00

* Covers 1940–42 inclusive and includes postwar tax refund.

† Covers 1940–42 inclusive and includes 1943 dividends paid or declared up to Oct. 7.

TABLE II—BARRON'S STOCK AVERAGES

	Aircrafts	Air Transports	50 Stocks
Oct. 7, 1943	28.40	34.38	78
Sept. 30, 1943	29.28	37.53	80
Sept. 23, 1943	29.01	38.11	81
Sept. 16, 1943	28.40	39.75	80
Oct. 2, 1942	31.92	23.03	62


Speeding
the Timetables of INVASION
Months ago a new and revolutionary tool of war . . . a giant troop and cargo transport named the Curtiss Commando . . . began to accelerate the timetables of invasion.
Today these great ships are swiftly spanning oceans and continents, transporting ever-increasing numbers of men, ever-mounting tons of supplies, to the theaters of action.
Commando performance in this new phase of military aviation has proved so effective that the U. S. Army has called upon Curtiss-Wright to devote facilities in four of its huge plants for the production of unprecedented numbers of these war giants . . . the world's largest twin-engined transports.
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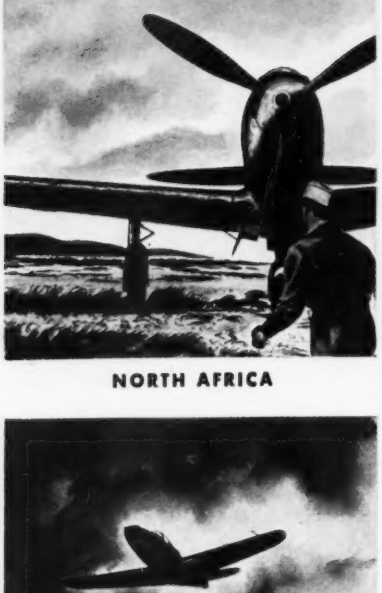
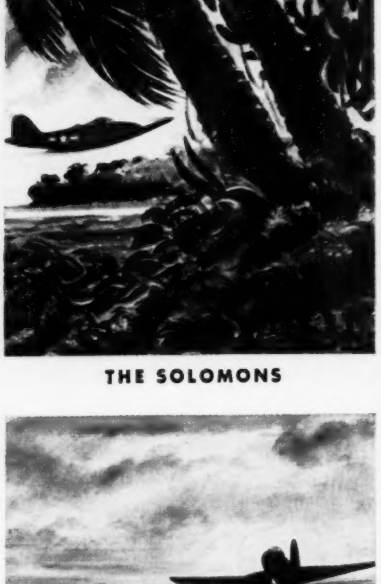
BUFFALO • COLUMBUS • ST. LOUIS • LOUISVILLE
Member: Aircraft War Production Council, East Coast, Inc.
CURTISS Commandos
FOR CARGO AND COMMERCE

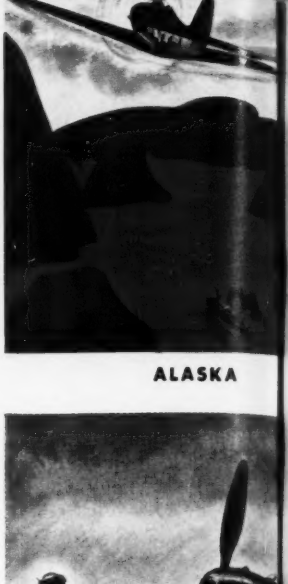
RUSSIA



NORTH AFRICA



THE SOLOMONS



ALASKA

PANAMA

ENGLAND

AUSTRALIA

THE CARIBBEAN

ICELAND

NEW GUINEA

THE SOUTH PACIFIC

HAWAII

See why we build 'em fast?

At all these major bases and active fronts, U. S. Army Bell Airacobras are in the air day after day and week after week

More are being readied for action in secret sectors that will explode into fighting fronts as our offensive plunges ahead.

A good fighter plane is basic in modern strategy. The Airacobra is a tough, fast, versatile, single engine ship armed with heavy machine guns and a cannon. No battlefront ever has too many good fighter planes like the Airacobra.

See why we put design engineering on a production schedule, developed short cuts in fabrication and built moving conveyor assembly lines?

See why we must build 'em fast?

MASS PRODUCTION TECHNIQUES, developed to meet the demands of war, will be ready and waiting to build the planes of peace. That's one reason why your postwar aircraft will be far better, far lower priced than the types you knew before the war. © Bell Aircraft Corporation, Buffalo and Niagara Falls, New York.

BELL *Aircraft*

AIRACOBRAS for victory—future planes for peace

BUY WAR BONDS AND SPEED VICTORY

"DOC" IS A FLIGHT SURGEON who says his work doesn't amount to much. He'd much rather talk about "my boys," members of a fighter squadron with a haircurling record. He even depreciates the special emergency kits he rigged up and supplied each pilot. But from other sources you learn of their value.

Not long ago, for example, one of his pilots had to bail out at about 20,000 ft. He only made one error—an error that couldn't be covered by Doc's instructions. He cracked his chute immediately, and the Jap kept making runs at him, shooting (and missing) till his ammunition was exhausted. Naturally unsatisfied, the little son of the setting sun made one final run—and his prop took off half the American's left foot.

Reaching into Doc's kit, the lad got out a shot of morphine and administered it to himself. Then, still floating seaward, he went to work. He took off the mangled shoe and sock, then removed his other shoe and made a tourniquet of the good sock. When he hit the water he put out his "shark medicine," and then rolled on top of his collapsible dinghy so that when it inflated he was inside. Finally, he dusted the wound with his sulfa powder, dressed it with gauze, and took his second shock pill.

Fortunately he was picked up almost immediately and taken directly to a base hospital. Because of his self-treatment, administered as he parachuted, surgeons were able to go to work right away; they didn't have to treat him for shock first.

Try to laud Doc for his kit and instruction and the only comment you get is, "that boy really had presence of mind. I sure was proud of him."

• Washington note: A hand-written card, signed by the janitor of a building we visited, advised passengers that "This elevator has just been oiled. That's the odor." With both thermometer and humidity pushing 100 on that particular day, the message relieved us no end.

• A route application to end all applications has been filed with the CAB; it is for "excursion service" and would permit the applicant to fly from any point to any other point in the country.

• The Pitifully Perplexed Personnel Manager reports that "if all the committees who went to the West Coast to study the manpower problem had just stayed and taken jobs there'd be no manpower problem."

• Pertinent question of the month is asked by the advisory board which represents 1,400 employees of a leading welding equipment manufacturer. On learning the company contracts were being renegotiated for 1942, this board wired the government representative: "We are producing at more than four times the rate per manhour of any of our competitors, as you know from your investigation. How much must we reduce this efficiency and raise costs to keep from being penalized in renegotiation? Please be specific. Should it be reduced ¼, ½, ¾, or more?"

• Going into Fort Worth, passing the famous stock show and rodeo buildings recently brought a severe case of nostalgia. It had been so long since we'd seen a steak we thought it would be nice to stop and look at one, even though it might be on the hoof. But there wasn't even a hunk of hamburger in the place. Instead of gazing on the contented face of "Susie Duroc 1598574" you see airplane wing jigs; where 4-H Club boys and girls once quieted their sleek yearling steers, you hear the whine of saws; where famed "Five Minutes to Midnight" kicked the saddling chute and bronc riders, you hear the louder thud of a drop hammer. Globe Aircraft had taken over; so through portals where once passed the most beautiful potential filet mignons and prime ribs in the world (remember?) now go airplanes—the Beech-designed AT-10 bomber-crew trainers. Believe it or not, they looked *better* than steaks.

SIDE SLIPS

If they change the aircraft insignia any more, Mr. Maguire, you're going to have to get some new skin.

YOUR MACHINES ARE ONLY

THE INGERSOLL MILLING MACHINE CO.,

AS GOOD AS THEIR CUTTERS

Your machine, regardless of how well designed and equipped in other appointments, gives the best performance only when operated with cutting tools designed for the job.

•

As a natural consequence of meeting and solving many machine problems in milling, Ingersoll has developed a line of milling cutters in types and sizes to suit the conditions of the work. These include cutters for face-milling, end milling, side milling, slotting, channeling, slabbing, form-milling, and many types of boring.

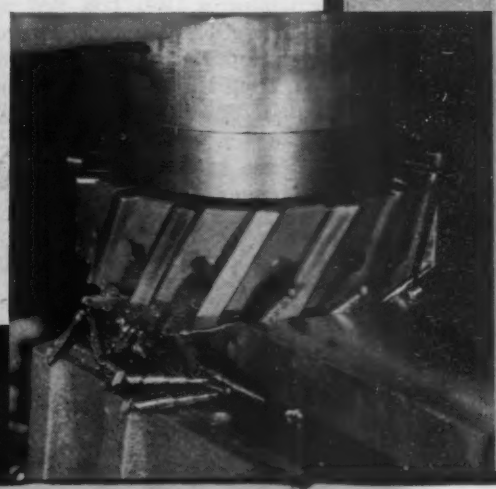
•

If you are not entirely satisfied with the performance of your machines, investigate their tooling. One example of how you may benefit is described at the bottom of this page.

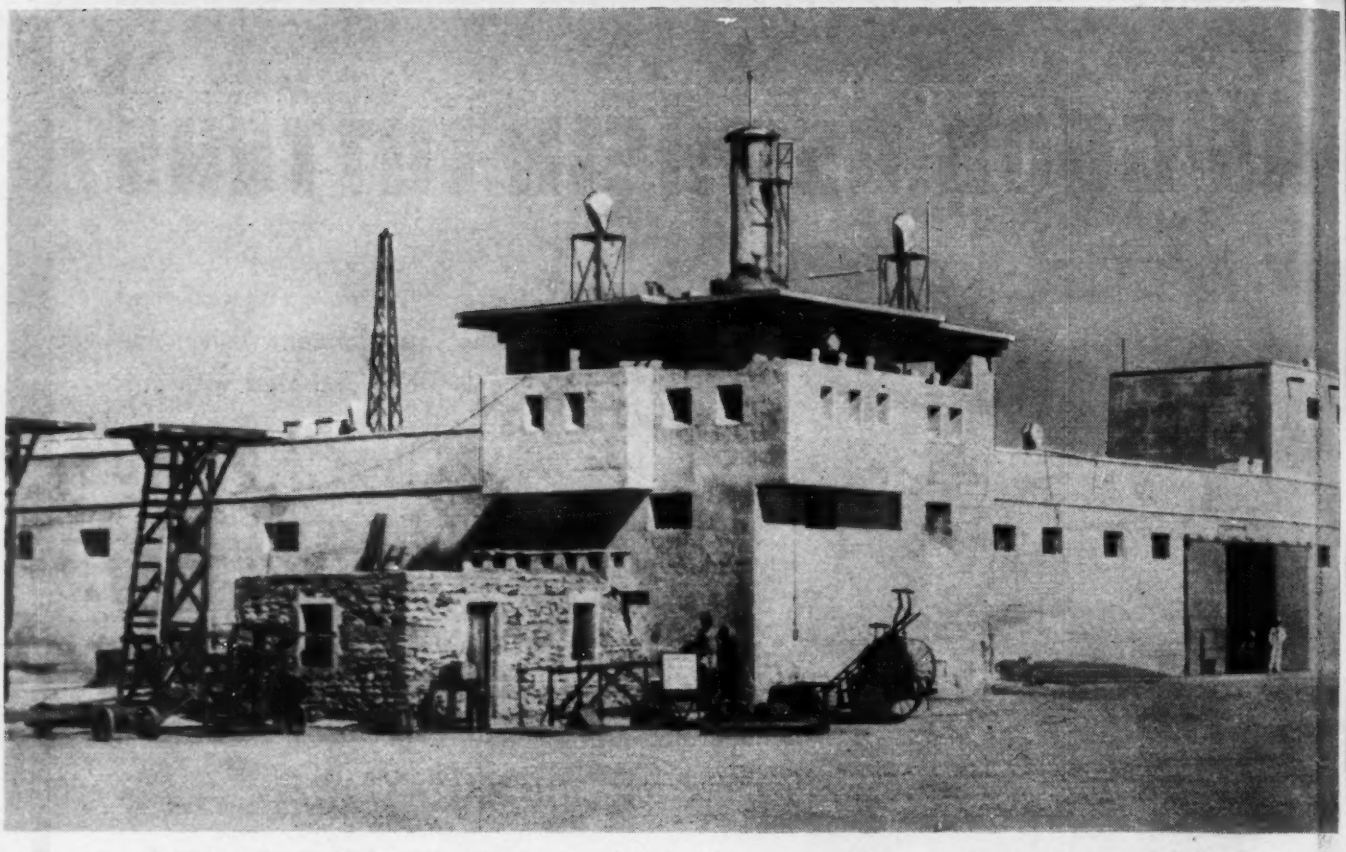
•

In stating the conditions of your work give (1) Kind of material being cut. (2) Width and depth of stock removal. (3) Nature of cut, such as face-milling, slotting, etc. (4) Type of machine drive. (5) And if convenient a sketch of the work-piece.

The same machine was used in both steel milling cuts shown below. The Shear Clear cutter on right, designed for jobs of this type, removed twice the amount of stock in less than half the time. The Shear Clear consumed less power and produced a smoother finish. Are you using the proper cutters in your shop?



ROCKFORD, ILL.



Modernism of Britain-to-Australia air route utilizes ancient Fort Sharjab, on Oman coast. Radio, meteorology, and beacon lights occupy corner watchtower where troops once kept weather eye out for hostile raiding tribes.

They Skyblazed Africa and the East "Way Back When"

Today's war takes flyers to many strange skyports. But it was yesterday's pioneers who hewed out the basic airways encompassing them. Told here is how England painstakingly launched prewar air routes over the "Dark Continent and beyond"—thus laying a potent cornerstone for postwar operations.

THE DAY KING GEORGE V was crowned in 1911, England saw its first airmail, a special flight from Hendon, just outside London, to Windsor Castle. By the time King George celebrated his silver jubilee in 1936, that first airmail flight of less than 20 mi. had developed into regular airmail service of over 13,000 mi. from England to Australia and more than 17,000 mi. to South Africa.

This was a startling growth in the short space of 25 yr., a development span interrupted by the long war years in the 'teens.

Toward the end, and also for a short period after the end of the last war, RAF planes carried military mail between London and Paris and, later, between Folkestone and Cologne. During the 1919 railway strike in England, 50 RAF aircraft were utilized for carrying domestic mail. Later, services to Paris and other Continental cities were rapidly multiplied.

While developing internal and Continental air routes, however, Britain had an eye farther afield—on the Dominions and Colonial Empire, Africa, the Middle East, India, the Far East, and Australia. It was in these far-flung domains that Britain concentrated on developing the rapidity of communication and transport which the young science of aviation could give. The story of the building up of these thousands of miles of overseas air routes is an epic of pioneering.

Only a month after World War I ended, RAF survey parties left for Cairo. Despite many difficulties, a survey of the route from Cairo to the Cape, across the African deserts and jungles, was completed by the end of 1919. For the next 10 yr. the route was the scene of many experimental flights by the RAF and some record-breaking attempts by private flyers, notably Sir Alan Cobham. But establishing a regular commercial route was a slow business due to the gigantic task involved.

In 1930, Imperial Airways, one of the constituent companies of the present British Overseas Airways Corp. formed just prior to the present war, took over this route. Dominion and Colonial authorities readily cooperated, not only helping financially but providing the necessary ground organizations. As men were trained in England to man the new air stations, others were out along the routes building airdromes, with hangars, workshops, and accommodations for passengers and staff, and for studying weather conditions and climate. Transport of fuel supplies had to be arranged in the difficult, and often almost im-

"Delia," a deHavilland 86 which, with its sister plane "Daedalus" pioneered trans-African commercial route from Khartoum, Anglo Egyptian Sudan, to Lagos, Nigeria, in 1936. Here, at intermediate landing field, left wheel has sunk out of sight in treacherous ground.

passable, terrain of fever-haunted jungle and scrub. In the vast swampy area of the Sudd, which stretches for hundreds of miles south from Khartoum to Lake Victoria, construction of airfields to stand up during the rainy season provided a tremendous problem.

It was solved by the use of flying boats on this section; they were moored on the Nile and at Kisumu sheds, and a slipway was built so the flying boats could be brought ashore for overhaul. Later, hardened runways were installed and a good all-weather airdrome resulted.

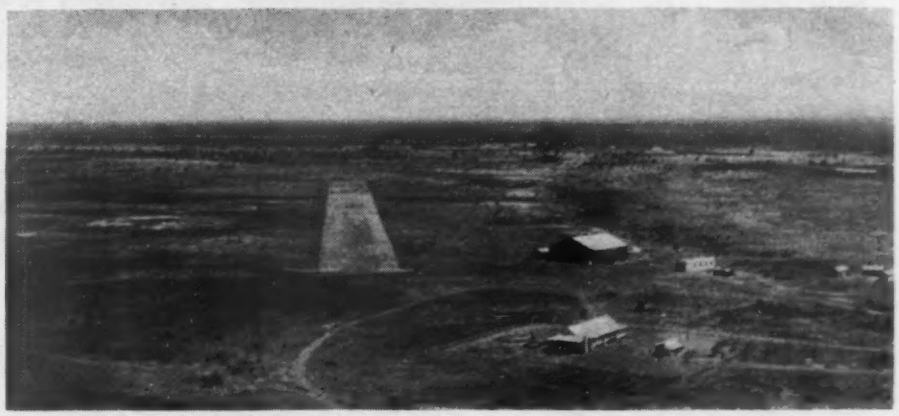
Other fields were built in the jungle. Here, it was necessary to take special precautions to protect passengers and staff from wild animals.

Altogether, 26 main dromes were constructed on the Cape-to-Cairo route, and 50 emergency landing grounds were prepared. At 17 of the main fields, radio stations were built. At many of the airports, fuel had to be brought in along bush paths by native porters.

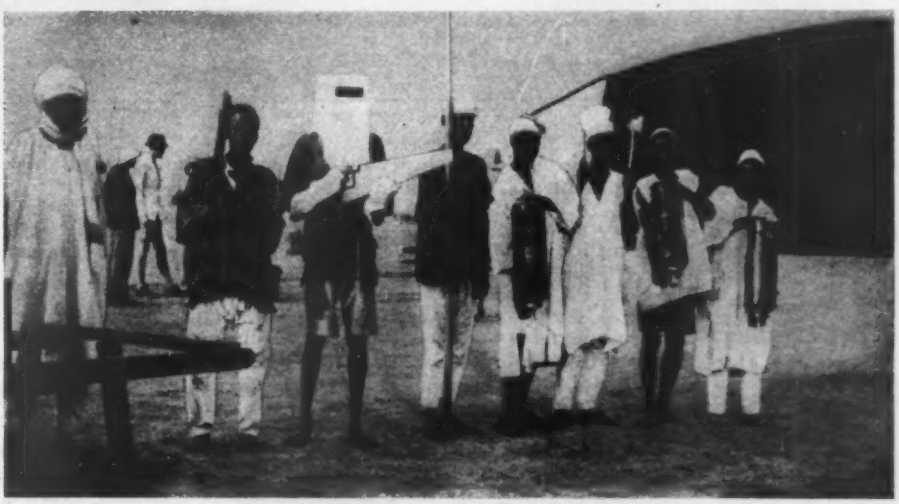
In the tropical regions, radio communication was extremely difficult. A joint investigation by the Marconi Co. and Imperial Airways resulted in the development of equipment to enable two-way communication between the air and ground on medium and short wavelengths.

By early 1931, the African route had

(*Turn to page* 281)



"Airport" at Fort Lamy, French Equatorial Africa, during early days of Khartoum-Lagos trans-African operation. Runway is of brick construction.



African natives who have never seen trains have long been used to aircraft as first RAF, then Imperial Airways, extended British airways net.

Absence of landmarks in desolate stretches of Syrian desert on the Amman, Transjordan, to Bagdad route made it, in some respects, more difficult than African runs. Deep furrows, such as these, were plowed at intervals by groundcrews to guide pioneering pilots to the landing runs.

IT'S no accident that that statement appears regularly in communiques from battles areas. It's been planned that way.

American planes and engines have been carefully designed—built to the most exacting specifications. American pilots and crew members—the world's finest—have been carefully selected, thoroughly trained.

After every flight, ground crew men—men who received intensive training, passed rigid examinations for mechanical ability—take over. Engines, planes and instruments are checked with infinite care—adjustments made wherever necessary—every precaution taken to insure mechanical perfection on the next expedition over enemy territory.

It's a safe bet that BONNEY TOOLS play a leading part in making sure of that perfection—help make necessary adjustments quickly, easily—help make possible many of those thrilling, heart-warming reports. Because with tens of thousands of engines produced by leading aircraft engine manufacturers BONNEY TOOLS are standard, original equipment with every engine shipped—selected because of quality proven through the years—quality that has earned them the reputation "the finest that money can buy".

The best engines and planes, skilled fliers, expert ground crews and BONNEY TOOLS—an unbeatable combination. All play their part in helping make possible the safe return of planes carrying America's Fighting Men of the Air.

BONNEY FORGE & TOOL WORKS, ALLENTOWN, PENNSYLVANIA

Make Your Reservations Early

AIR TRANSPORT

Travelers do not realize what a vast, efficient combination of men and machines is put in action when they telephone requests for information regarding airline reservations. UAL's skillful system of handling passenger traffic is explained here.

Under United Air Lines reservations system, chief reservations clerk, control clerk, and control desk chief decide in a few seconds whether space requested is available.

In its policy of improving wartime reservations service United Air Lines insists that its clients be served more efficiently, if possible, than in peacetime and that every DC-3 *Mainliner* be employed to the greatest possible advantage.

War travel has put the reservations department of the line to the test. Non-priority passengers frequently must yield seats to those on war missions, to expedite whose travel United today has 300 persons in its reservations service, all of them trained for months before they handle even a simple request.

Stations of United Air Lines are linked by a network of communications, so that a request for a seat on a flight to be made from the opposite coast can be handled in ten minutes and for a local flight in as little as two minutes. United's communications system comprises circuits spanning 7,800 mi. and connecting all offices simultaneously. Ten key centers are connected on separate trunk lines to avoid bottlenecks. At the switching center messages are recorded on a tape which passes to a transmitter and, without further attention from the operator, are forwarded to the proper station.

A feature of the switching center is the master sending unit which was developed for speed in getting messages to a number of addresses simultaneously by inserting a plug and depressing the push buttons controlling the various circuits. In the switching center are also located radio operators, Western Union and Postal Telegraph machines, and an elaborate network of telephones to various local offices. UAL has 20 leased telephone circuits in each of its major reservations offices. Five of these are direct hookups with traffic offices—one at the airport terminal and others at key points in the city.

With this communications system, queries are transmitted and answers relayed swiftly. Calls received at Chicago run two per minute, during the busy period and one a minute for a daily average.

To understand how this work is performed it would be helpful to follow a reservations request. Let us suppose that John Doe says he is interested in a reservation from Chicago to New York on the 5 p.m. *Mainliner* on Nov. 15. The operator routes the call to a

They battle the enemy with bombs and bullets

...they baffle the elements with VALSPAR

Scourge of the seven seas, "Buccaneer", the Navy's Brewster Bomber, teams up with other carrier-based planes like the F3A fighter—famous "Corsair"—in carrying the fight to the enemy unceasingly.

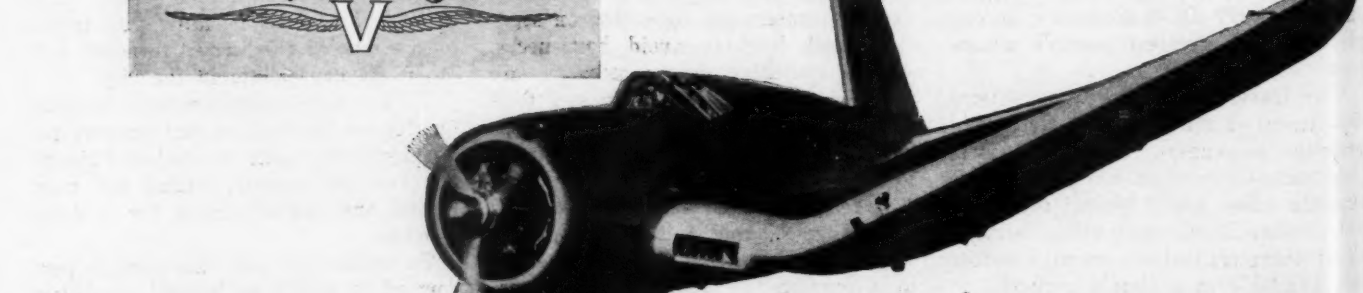
No less constant is the daily battle against the corroding action of wind, water, sea and sun. Metal though it is, the precious skin of fighting ships needs a finish that fends off the fury of the elements, and camouflage to foil searching enemy eyes.

Brewster finds Valentine's Valspar Val-Aero furnishes that finish very satisfactorily, says—"all of our bombers use some of their products. Some of our bombers are completely covered with Valentine finishes—primers as undercoat and colors as camouflage."

We find a great thrill in the knowledge that our products are helping the fight for freedom.

VALSPAR
VAL-AERO

PRIMERS, LACQUERS, ENAMELS. *A complete line of dependable Aircraft Finishes—that meet Government specifications. • Valentine & Company, Inc., 11 East 36th St., New York, N.Y. Established 1832. • Makers of the Famous Valspar Finishes*



Typical communications center is this unit at Chicago. Teletype enables reservations staff to communicate simultaneously with all offices on United Air Lines' 7800-mi. system.

United Air Lines service department provides fast accurate answers to innumerable questions asked by prospective travelers about schedules, fares, connections, limousine service to airports, and many other matters. This center also specializes in handling calls from outlying stations in area.

sales person handling requests for reservations on this particular flight and gives the name of the prospective passenger. The saleswoman then jots on a reservation card the name, address, business address, telephone number, whether limousine pickup is desired, and the name of the person requesting the reservation if it is other than the prospective passenger. If the prospect is a regular traveler most of this information is already in the "telefile," an index of frequent passengers.

If, however, Mr. Doe is not a frequent traveler the telephone salesperson prints the above information on the card, also the first stop-over point and the date on which the reservation was requested. This last information is important because postponed reservations are handled strictly in rotation. The salesman—or more often saleswoman—then checks with the space control desk; for if a seemingly insignificant error is made there, it is quite possible that a flight may be oversold.

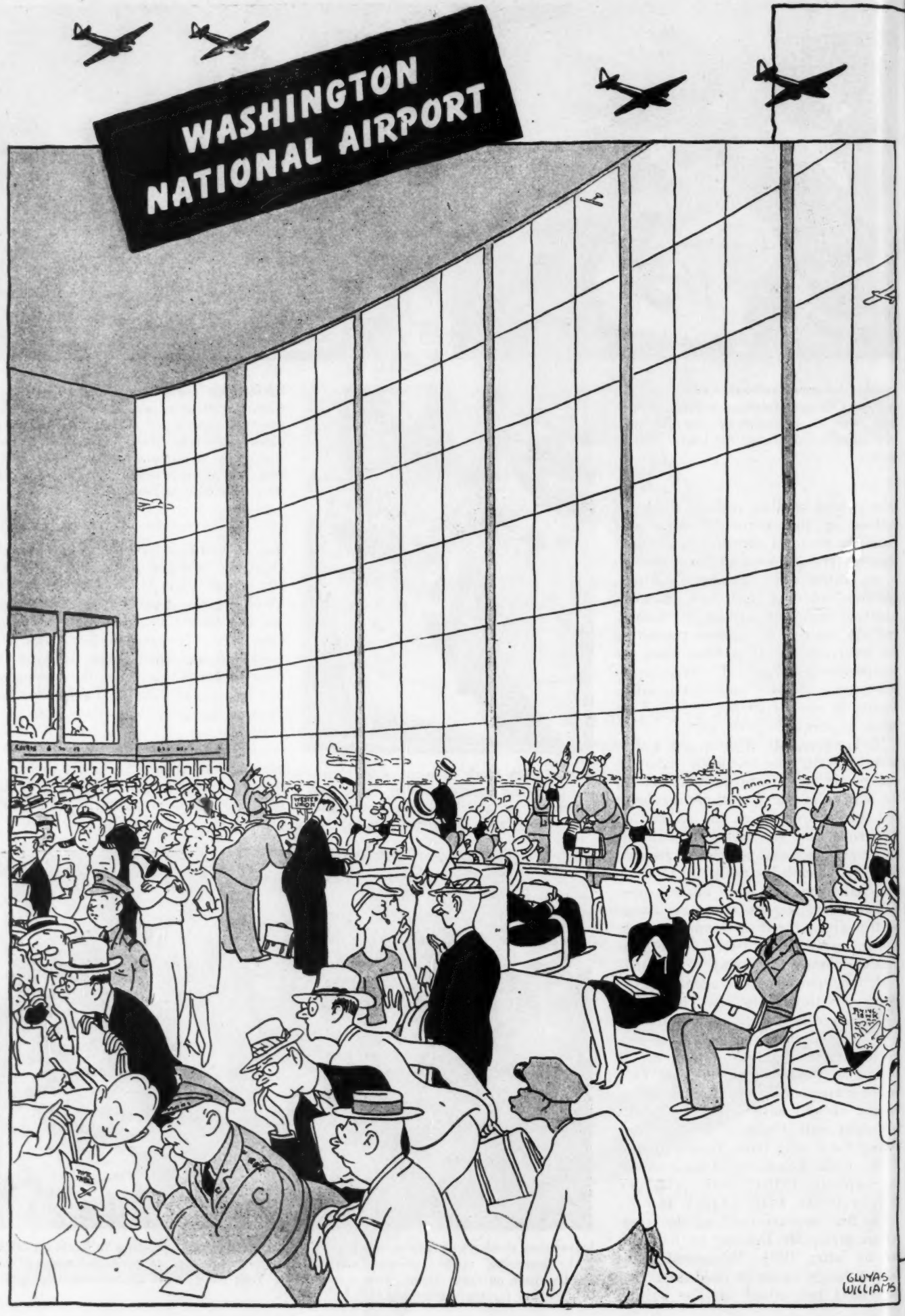
If the space control agent has an empty seat through to New York in his control, he confirms the reservation and notes the passenger's name on the control chart for Flight 48 of Nov. 15. If he has no through seats to New York in his control, he has other alternatives. Should he still have a seat to Toledo, he might call United's Toledo office, asking for a seat from Toledo to New York. From Toledo would come one of two replies: CONE DOE ATLYNY 48-1, or UNAC DOE ATLNY 48-1..

The first message confirms the reservation, giving Mr. Doe seat no. 5 (signified by letter "E"); the second states that Toledo's space is sold and that they have two others on the waiting list. If Toledo is "unable," Chicago will determine whether there is a seat for him from Chicago to Cleveland. If Cleveland has space, Chicago will book Mr. Doe from Chicago to Cleveland and then from Cleveland to New York on Cleveland controlled space. If none of these bookings is possible, the passenger will be advised that an attempt will be made to book him on a later flight.

By the use of the two-way telemeter system, inter-office communication regarding the reservation is so efficient that the request can be handled while the client waits momentarily at a telephone.

Before each clerk in space-control center are charts for each scheduled flight. Here allotments are made and space information forwarded to sales department.

Increasing numbers of reservations require maximum speed and efficiency in handling calls. UAL "screening" method switches calls regarding certain trips to personnel assigned to handle space on these flights. This view of New York office shows clerks with trip cards before them for ready reference.


WASHINGTON
NATIONAL AIRPORT
GUYAS
WILLIAMS

...WHERE PLANE TRAFFIC IS BUSIEST

CUNO FILTERS PROTECT ALL FLIGHTS

1201 take-offs and landings in one week at the National Airport — where three leading airlines, American, Eastern, and Pennsylvania Central, converge on the nation's capital.

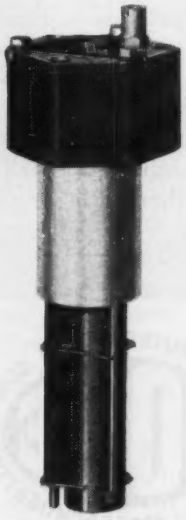
Every plane was checked — and *every plane* was found equipped with Cuno Filters, assuring constant flow of clean fluids to vital parts.

Cuno was the first, you know, to develop filters for positive, uninterrupted removal of sludge in aircraft engine lubrication. As a result of continuing collaboration with aeronautical designers, other aircraft fluid systems, such as hydraulic control, supercharger lube, and glycol heating systems, are now also Cuno-protected.

Today, most engine and aircraft builders use Cuno Filters because they provide non-stop protection . . . because their dependability has been proved by millions of miles in the air . . . and because the maintenance problem has been reduced to a minimum.

CUNO . . . A SAFE SHORT CUT IN MAINTENANCE

Cuno Filters are continuously cleanable, and operate without attention for much longer than the longest flight. Our maintenance-advisory staff, working closely with service depots, has conclusively established the speed and ease with which Cuno installations are kept at top-flight performance.



COMPLETELY AUTOMATIC FILTRATION

Cuno's self-cleaning filter was developed with the assistance of prominent aviation engineers. Mounted on the filter is a tiny hydraulic motor powered by the oil it helps to keep clean. By this means the filter element is continuously rotated past cleaner blades which positively comb out all imbedded as well as adherent solids — automatic protection against sludge and undesirable solids as long as the system is under pressure.

CUNO ENGINEERING CORPORATION
711 South Vine Street
Meriden, Connecticut

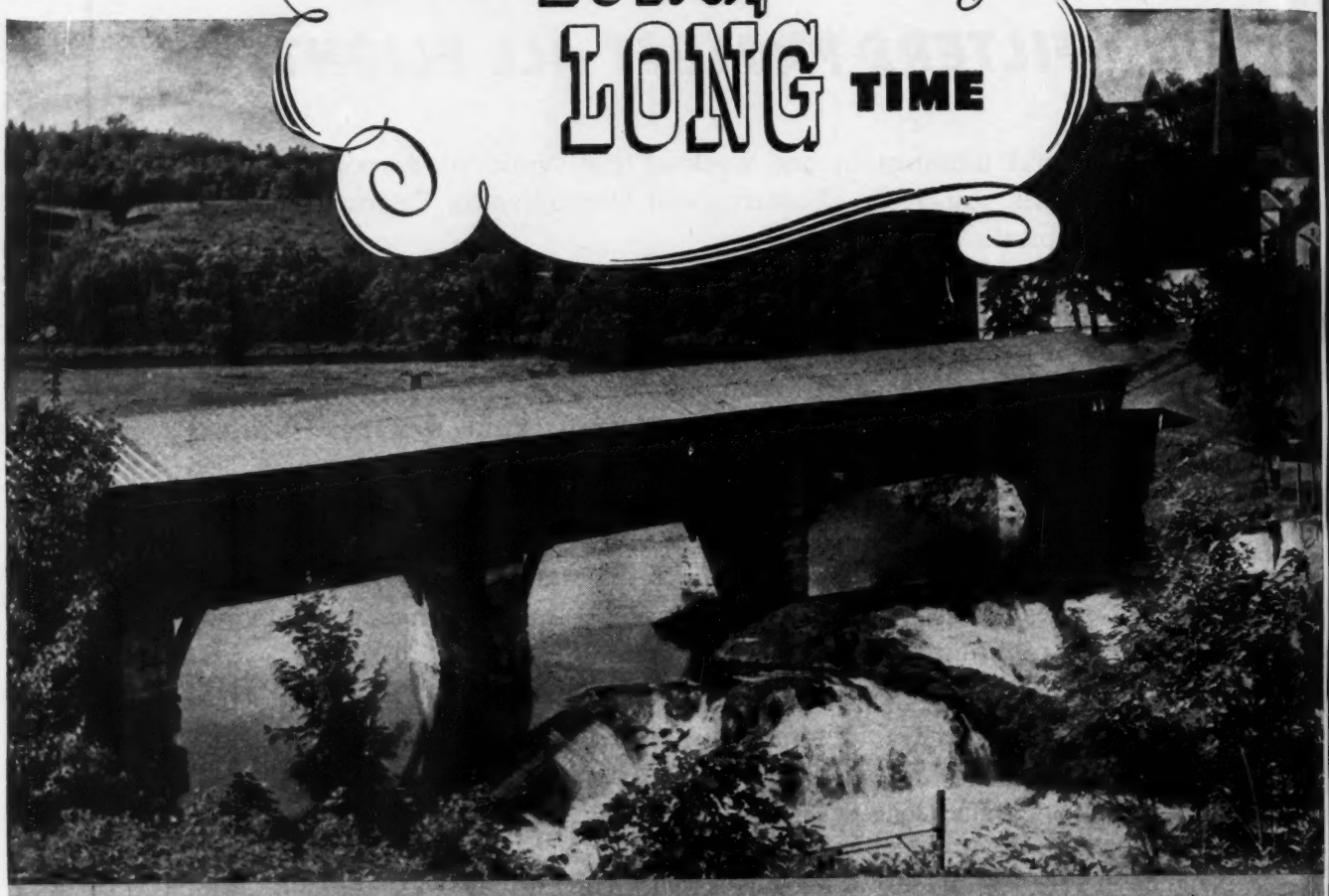
KEEP FLOW ON "GO" WITH

CUNO

THE "FILTER-FINE" STRAINER

← Illustration courtesy The New Yorker Magazine

FOR A LONG, LONG TIME



LONG-LIFE ASSURED

For This Unique Capacitor

One reason why Tobe Capacitors have forged to the front **is their consistently long life. But there's another reason — the successful pioneering work of Tobe engineers.**

Take as an example the CA—355, shown below in streamlined, hermetically sealed drawn container. It is being used in large quantities by the U. S. Army Signal Corps in front line telephones.

Tobe is the only manufacturer furnishing this capacitor in a drawn container.

The CA—355 is just one instance of Tobe engineering ingenuity in developing and perfecting new devices. However tough your own condenser problems we invite the opportunity for our engineers to help you solve them. Please get in touch with us.

SPECIFICATIONS—CA—355

Wax impregnated, wax filled capacitor

Capacity Rating:.....2.0—0.5—0.3 mfd.
Voltage Rating:.....200 D C
Power Factor:..@ 1000 cycles .01 maximum
Resistance:....2000 megohms per microfarad
Dimension: 1" depth—2½" length—2⅛" height

Meets requirements of U. S. Army Signal Corps

TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS

***A small part in victory today*—A BIG PART IN INDUSTRY TOMORROW**

How AA's Propeller Shop "Keeps 'Em Turning"

By EDWARD E. THORP

MAINTENANCE

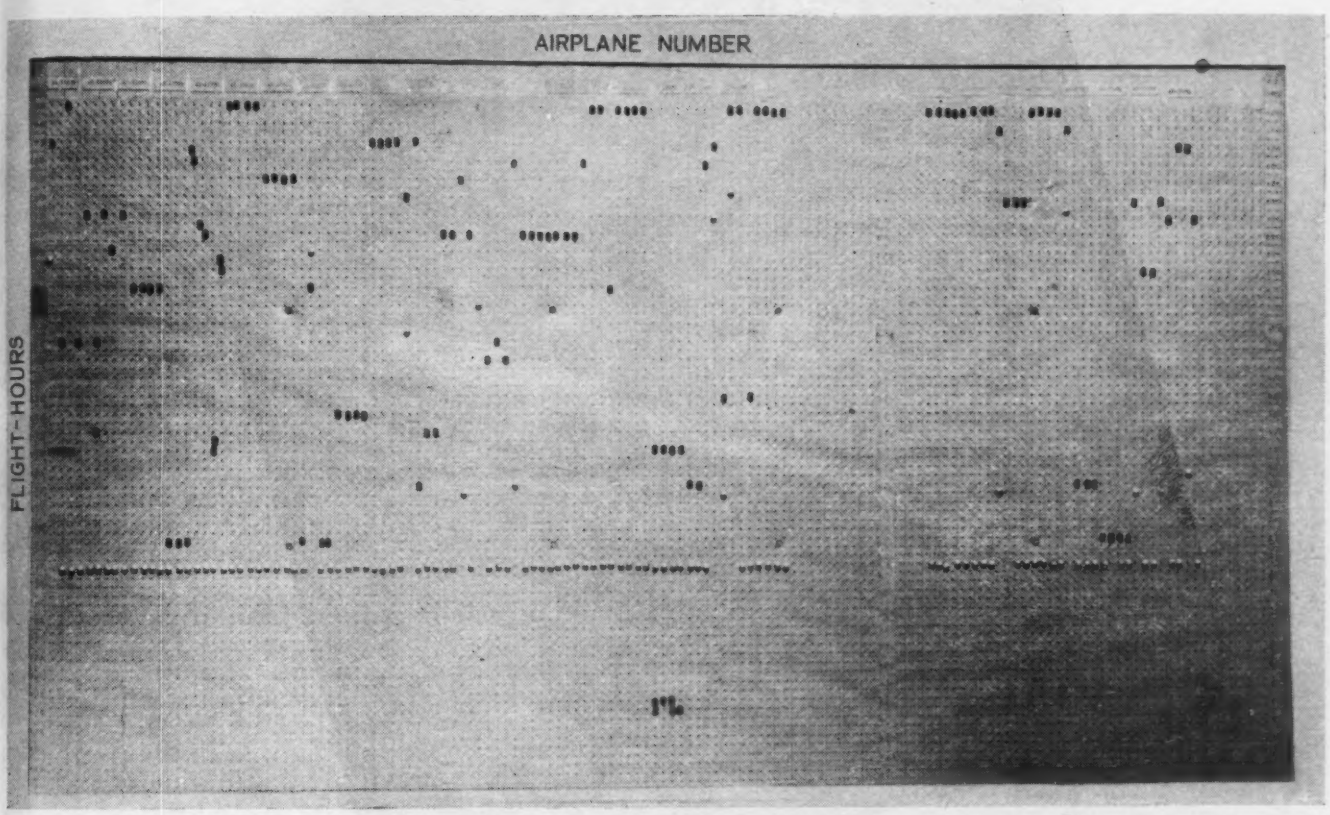


Fig. 1. On this board is kept record of each airplane, engine, and propeller. Line of white pins represents 650-hr. overhaul period.

A single, comprehensive shop handles all propeller overhauls for AA's nationwide system. Detailed here are the precise means by which airscrews are maintained at top efficiency.

REGARDLESS OF DISTANCE, all propellers used by American Airlines are overhauled and serviced at the company's shops at LaGuardia Field, N. Y. By concentrating this work among highly skilled specialists, the efficiency of the operation has been raised to a point where a three-blade propeller usually is completely overhauled in 32 man-hours. Highest output for one month, so far, was 78 propellers, where two shifts were employed.

Though all the mechanical operations are handled in a shop 40 ft. x 60 ft., the method of routing the propellers on the floor is such that crowding and bottlenecks are entirely absent.

To record the flight-hours of the engines and propellers, a planning board (Fig. 1) is used which deserves specific mention. This board, measuring about 30 in. x 36 in., is made with a soft backing which will hold pins. On its surface is pasted a chart, ruled in vertical columns, one for each airplane. Horizontal lines are used to indicate the number of flight-hours. Over the face of

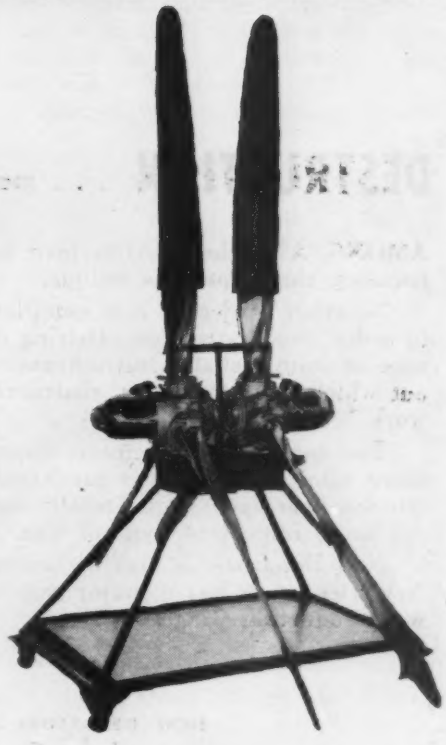
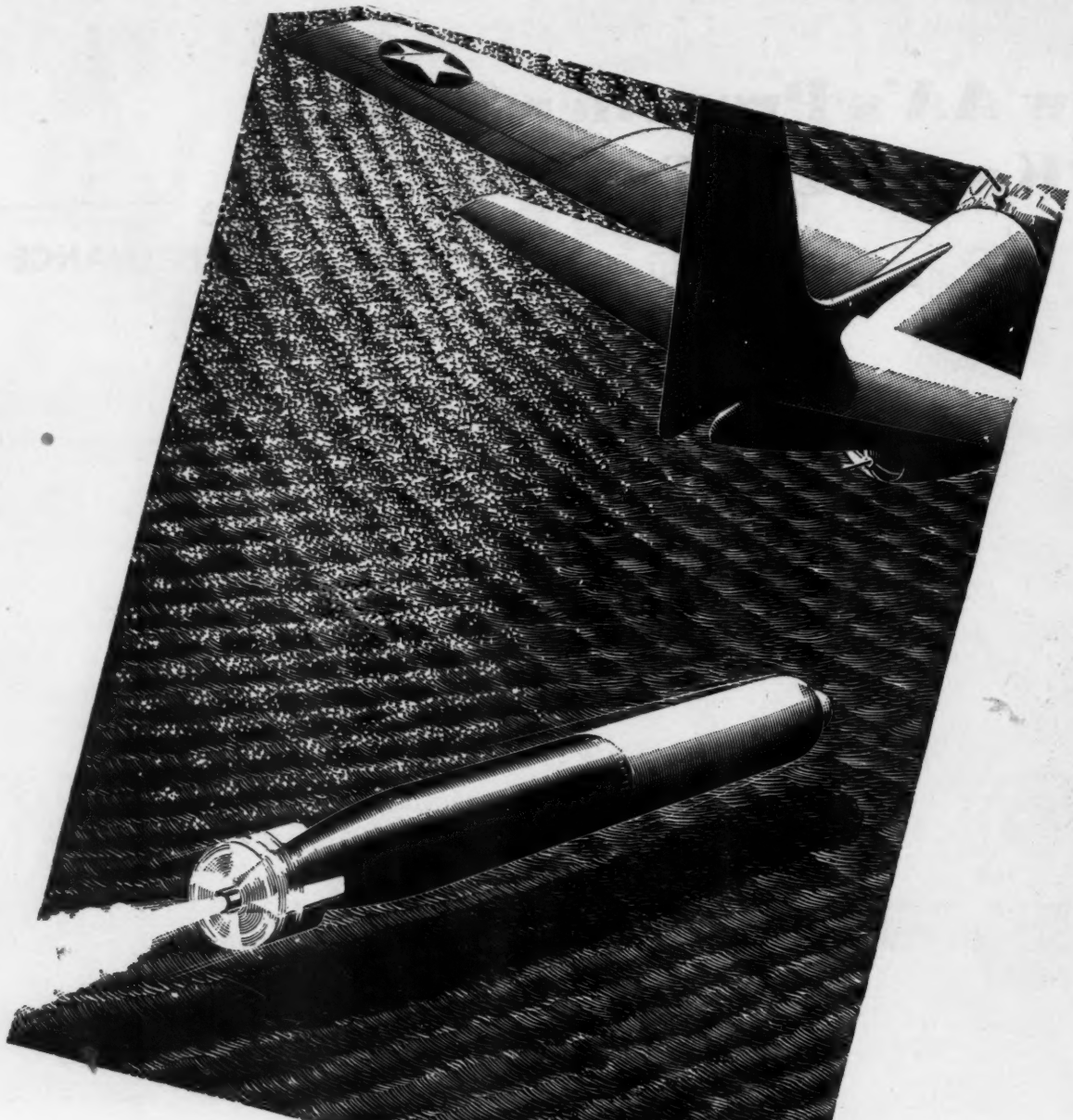


Fig. 2. Storage stand built by American Airlines.



DESTRUCTION . . . *made to order*

AMONG ALL the missiles man has contrived to hurl death at his enemies, the torpedo is unique.

No other projectile is so complex, so carefully engineered, so "made to order" for destruction. Driving the deadly "warhead" is an intricate mass of motors, shafts, instruments—and *bearings*. Ball bearings—without which neither motors, shafts, nor instruments could "do their best work."

The torpedo is one more illustration of the fact that there is no more vital factor in the mechanized war we fight today than anti-friction bearings. They literally *make possible* the *sustained* action of our more important tools of war.

New Departure is making bearings by the tens of millions. In fact New Departure has a major responsibility in the whole ball bearing war production program.

3207

THE TIME IS NOW

Bearing application is a highly specialized art. Wisdom dictates consulting our engineers on new designs while yet in the formative stage.

NOTHING ROLLS LIKE A BALL

New Departure

THE FORGED STEEL BEARING

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

AMERICAN AIRLINES, INC.
PROPELLER INSPECTION-OVERHAUL RECORD

PROPELLER MFG. _____ TYPE _____ JOB NO. _____ DATE _____
SERIAL NOS.-BLADE NO. 1 _____ NO. 2 _____ NO. 3 _____ HUB _____
DRAWING NOS. - HUB _____ BLADES _____ REMOVED FROM SHIP NO. NC- _____ DATE _____

TIME ON	SINCE INSP.	SINCE RE-MFG.	HUB TOTAL	BLADE 1	BLADE 2	BLADE 3	ENGINE NO. ☐L ☐R
PROPELLER							

RECEIVED FROM _____ REASON FOR REMOVAL _____ BLADE TORQUE IN FT. LBS. 1. 2. 3.
BASE SETTINGS HIGH _____ LOW _____ CONDITION BEFORE SERVICING _____
DIAMETER _____ FT. _____ IN. SPIDER AND BARREL ALIGNMENT _____ TRACK _____

STATION	WHEN RECEIVED									AFTER SERVICING								
	ANGLE			WIDTH			THICKNESS			ANGLE			WIDTH			THICKNESS		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
18																		
24																		
30																		
36																		
42																		
48																		
54																		
60																		
66																		
72																		
LOW 42																		

CONDITION AFTER SERVICING _____ BASE SETTING - HIGH _____ LOW _____ DIAMETER _____ FT. _____ IN. _____ TRACK _____
REPLACED BLADES _____ DRAWING NOS. _____ HUB _____ BLADES _____ REASON FOR REPLACEMENT _____
SERIAL NOS. HUB _____ BLADES 1. _____ 2. _____ 3. _____ TOTAL TIME HUB _____ BLADES 1. _____ 2. _____ 3. _____
BLADE TORQUE IN FT. LBS. 1. _____ 2. _____ 3. _____ SPIDER AND BARREL ALIGNMENT _____ HUB PLATED _____ MAGNAFLUXED _____
BLADES STRAIGHTENED _____ MISCELLANEOUS PARTS REPLACED REQUISITION NO. _____
DISPOSITION _____ DATE _____ PRELOAD DONE _____ BARREL _____
REMARKS: _____
BLADES RECONDITIONED BY: _____ BLADES TRIMMED BY: _____
CHECKED AND BALANCED BY: _____ INSPECTED BY: _____ APPROVED: _____

Fig. 3. Propeller inspection-overhaul record. A complete check is kept on this sheet of hub and blades. Portion to left and above heavy line is filled out on receipt of propeller and during preliminary inspection. Balance of sheet records work done in servicing and is signed by each man who does work. This and other related sheets form a life history of propeller.

the board is placed a sheet of celluloid, perforated with two rows of holes for each column. Colored pins are used to designate the engines and propellers and are moved down the columns as the number of flight-hours increases. At the point corresponding to the overhaul period—in this case, 650 hr.—a white pin is placed when the engine or propeller is installed, so that when one of the colored pins arrives at this point, the engine, with its propeller, is due for overhaul.

It is obvious that there can be no possibility of the equipment being run for longer than the specified time without overhaul, since the board supervisor will be visibly reminded of its status whenever he records the time of either the engine or propeller.

After the propeller has been removed

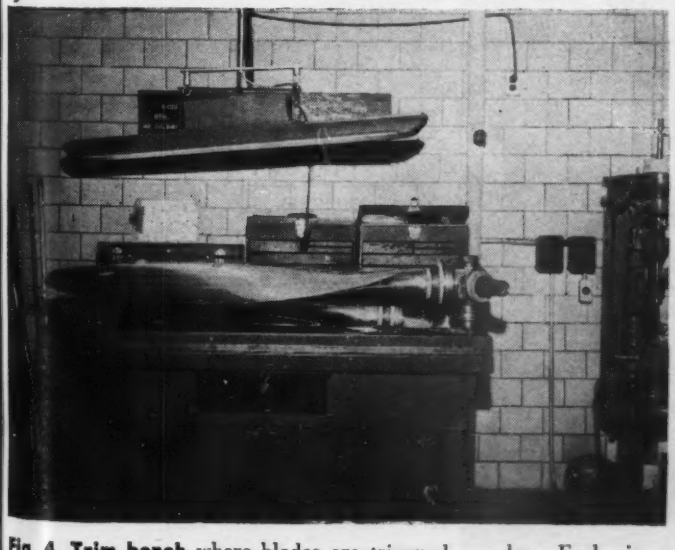


Fig. 4. Trim bench where blades are trimmed on edges. Each airscrew is handled as a separate job.

Fig. 5. Grinding and balancing stand. Weight and thickness are constantly checked as surfaces are ground.

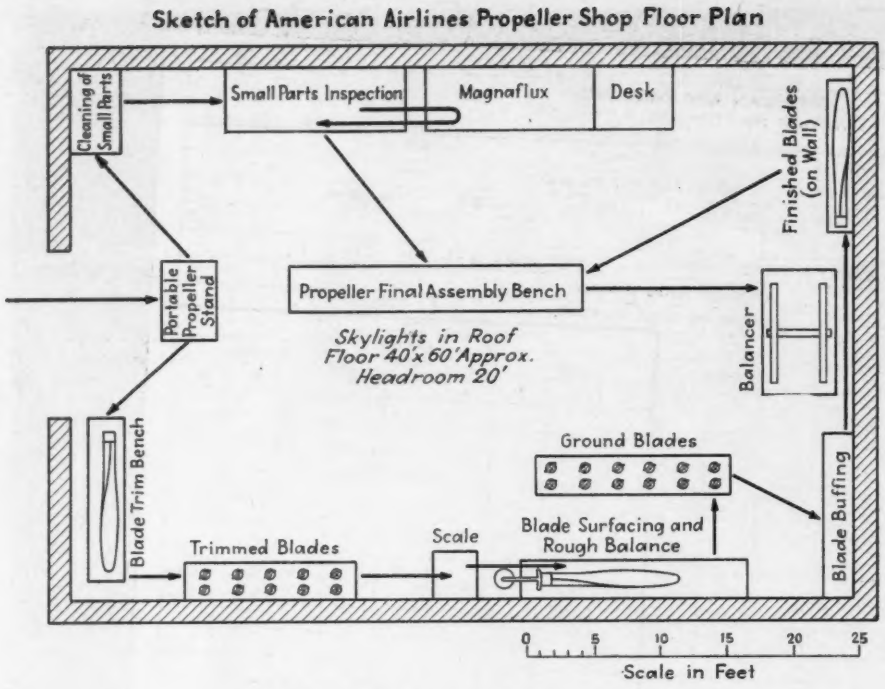


Fig. 6. Floor plan of propeller shop.

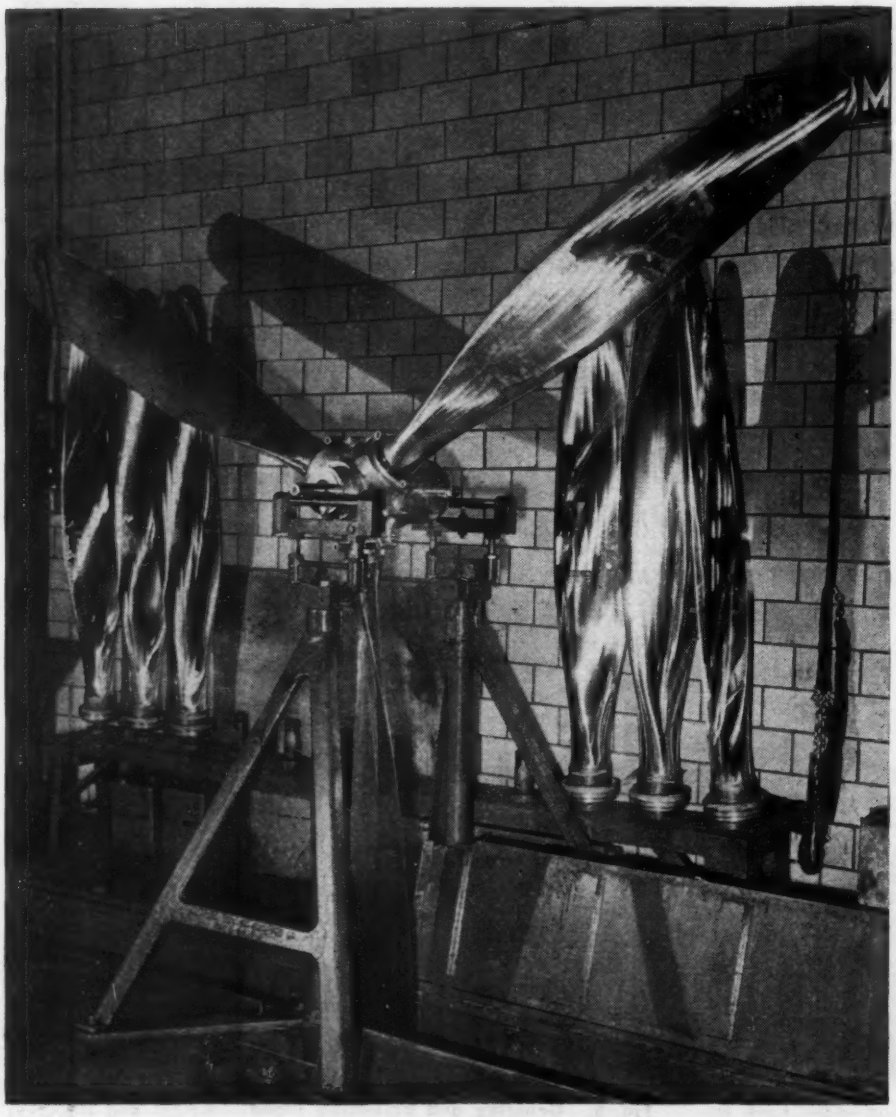


Fig. 7. Balancing stand and blade rack.

from the engine, it is mounted on a portable stand to await its turn in the shop. These stands are built in the airline shops from ideas originated by the men who do the work, and for this reason they are thoroughly practical.

When its turn comes for overhaul, the propeller is wheeled on its stand into the shop. Here the preliminary entries are made on the inspection-overhaul record (Fig. 3) while the propeller is being disassembled. On the rare occasions when straightening or machining are required, the parts are sent to another shop at this time. In any case, the blades follow a routing separate from that of the other parts, until final assembly is reached.

Blade Routing

First the blades go to the trim bench (Fig. 4) where each is handled as a separate job, though, of course, comparative dimensions are checked frequently as the work progresses. The center lines and cross stations are marked in pencil on the face of the blade, the stations being 6 in. apart. The mechanic then files the contour of the blade, to remove all blemishes, keeping within the dimensions given in the table of trim limits, which hangs on the wall behind his bench. Limit set by the manufacturers is $\frac{1}{16}$ in., but American Airlines' own tolerance is .020 in. This meticulous attention to detail is evident at all stages of the work.

After entries are made on the record sheet, the trimmed blades are placed in the rack to await the surfacing operation.

The blades are next placed in the balance at the surfacing bench (Fig. 5) where they are surfaced with a portable

(*Turn to page* 290)

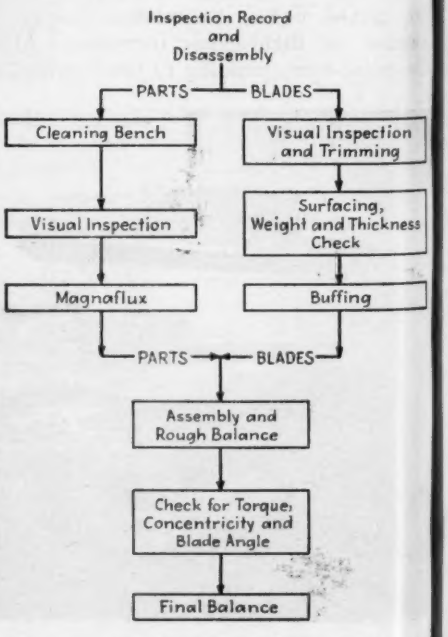
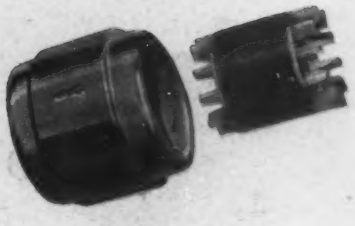


Fig. 8. Routing of blades and parts through American Airlines shop.

There is a size and type **LOUIS ALLIS** *electric motor for every industrial requirement.*



THE LOUIS ALLIS CO., MILWAUKEE, WIS.

Let's first WIN this war!

We won't ever have a second chance—

The Gerjaps are waging a vicious determined war — a cruel fanatical war to kill, conquer and loot their foes — a war of no quarters and of no compromise — either we defeat them — or they will conquer us!

And unless WE win — neither we nor our children's children will ever have a second chance.

We here at Louis Allis are forcing our every effort in every way to help win this war — to get it over as quickly as possible.

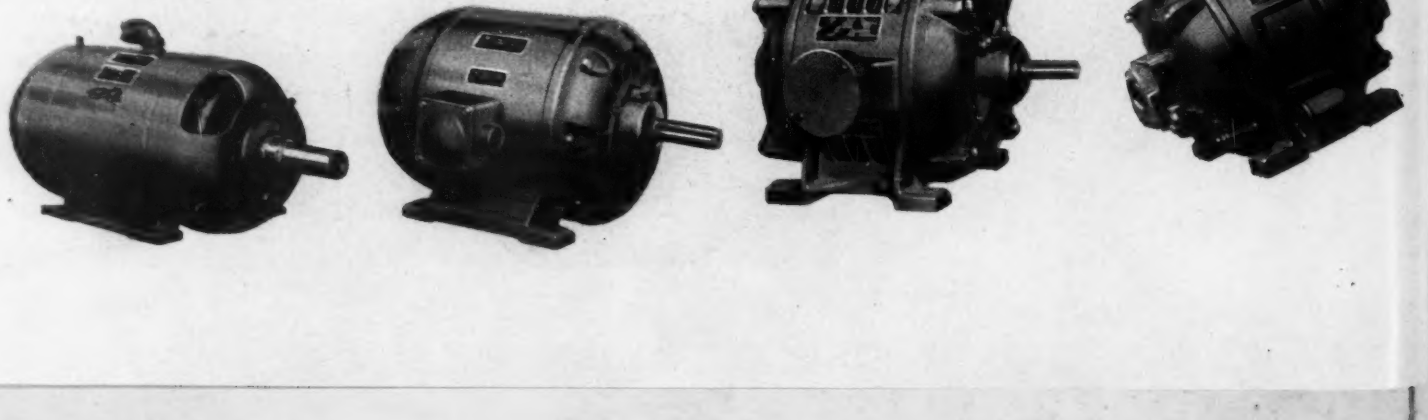
Our engineering development department has created many outstanding — perhaps revolutionary — improvements in electric motor design — construction and performance —

Motors that are serving a major important role in helping your boy and mine win this war — to help bring him back home — safely — as quickly as possible.

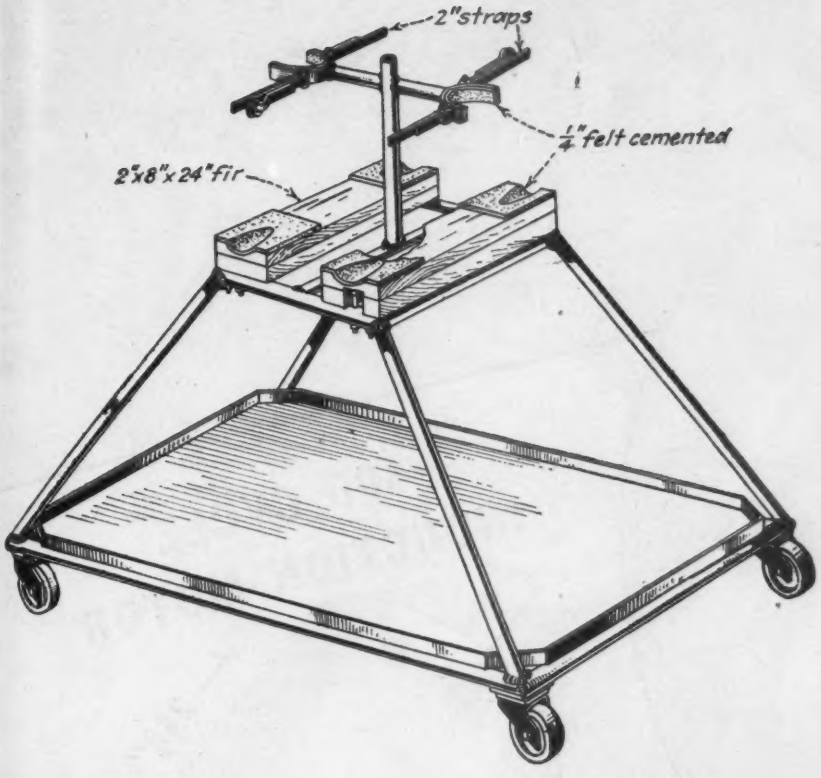
Many of these important new motor developments will also play an important role in the post war period.

But now is not the time to discuss them — let's first WIN this war!

THE LOUIS ALLIS CO., MILWAUKEE, WIS.



AVIATION'S MAINTENANCE NOTEBOOK



American Propeller Storage Stand

• American Airlines built a number of these stands for both storing and handling their 11½ ft. 3-blade propellers used on DC-3's. The frame is welded of iron pipe with a sheet metal drip pan which is also useful for tools and small parts when working on the propellers.

The vertical blade is held in the felt-lined fork by webbing straps while the other two blades rest in grooves in the fir blocks on the top platform. Two propellers are held in one stand with easy access to either one without interfering with the other. Ball bearing casters enable the stand to be moved with a minimum of effort.

Centrifugal Sand Spreader by TWA

• For sanding icy ramps and areas around passenger terminals, TWA, after some experiment settled on this simple trailer unit, consisting of sand or grit hopper, ¾ hp. gasoline engine driving, by V belt, pulley and shaft, a bladed wheel. Operated at about 600 rpm. the device will evenly sand a strip about 30 ft. wide. It requires only two men to operate—one to drive tow truck and one to stand by trailer and engine. Has given good service for TWA.

Southwest Airways Brake Assembly Tester

• Maintenance Superintendent Guy Polson of Southwest Airways devised this stand for testing brakes before mounting on landing gear. It consists of a spring landing gear section on an angle-iron stand, which also carries pressure device for testing relined brake shoes or trued drums. This machine may also be used for testing brake cylinders.

400 CYCLE INDUCTION MOTOR

This small 115 Volt induction motor is the latest addition to the E.A.D. line of 400 cycle equipment. It may be used for general applications requiring 1/50 HP continuous duty at 7200 RPM in most fields where DC motors were used heretofor. It is outstanding for its high efficiency and power output within its small size and light weight. Length 2⅞", diameter 1¼", weight 15 oz. Cooling is accomplished with self-contained fan. It has been particularly useful in driving small blowers.

We Invite Inquiry

This motor is obtainable in either 3 phase or single phase capacitor. Inquiries are invited concerning modifications for special control purposes.

Unique research, engineering, tool making and production skills combine to build not only control devices that fulfill the most exacting requirements, but also to build special purpose devices for which no specifications exist. Our list of customers, the most exacting in government, aviation and manufacturing, attest to these skills.

Manufacturers of *Control Devices*

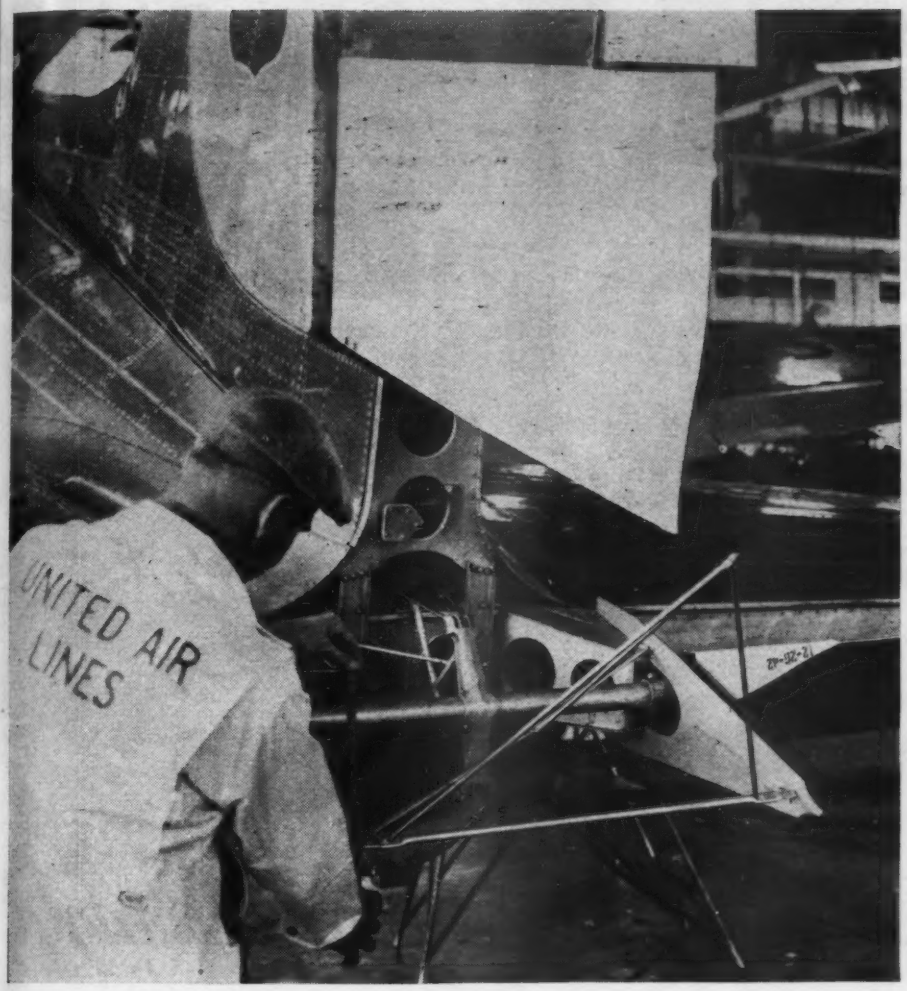
and Components . . . for Electrical, Electronic and Mechanical Applications

EAD

EASTERN AIR DEVICES, INC.

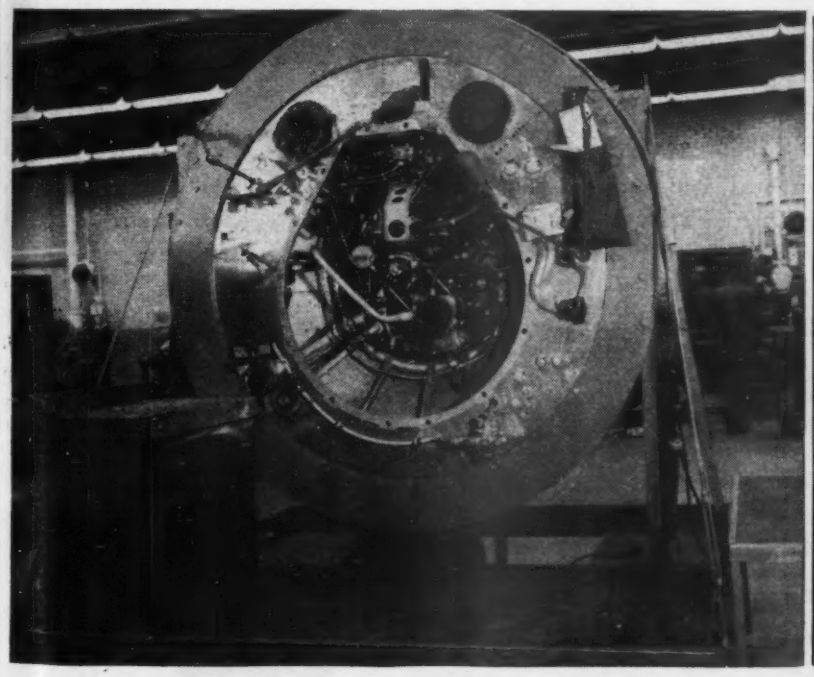
585 DEAN STREET • BROOKLYN, N. Y.

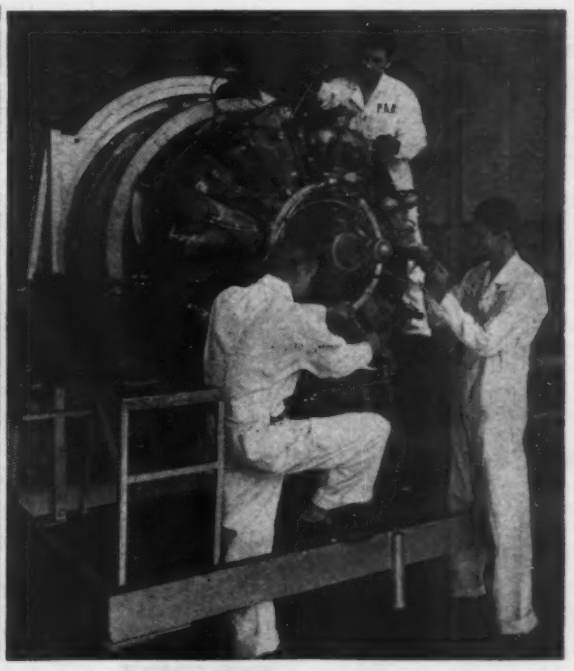
An Affiliate of THE FRED GOAT CO. INC., *Special Machinery Specialists Since 1893*



UAL Tail Surface Jig

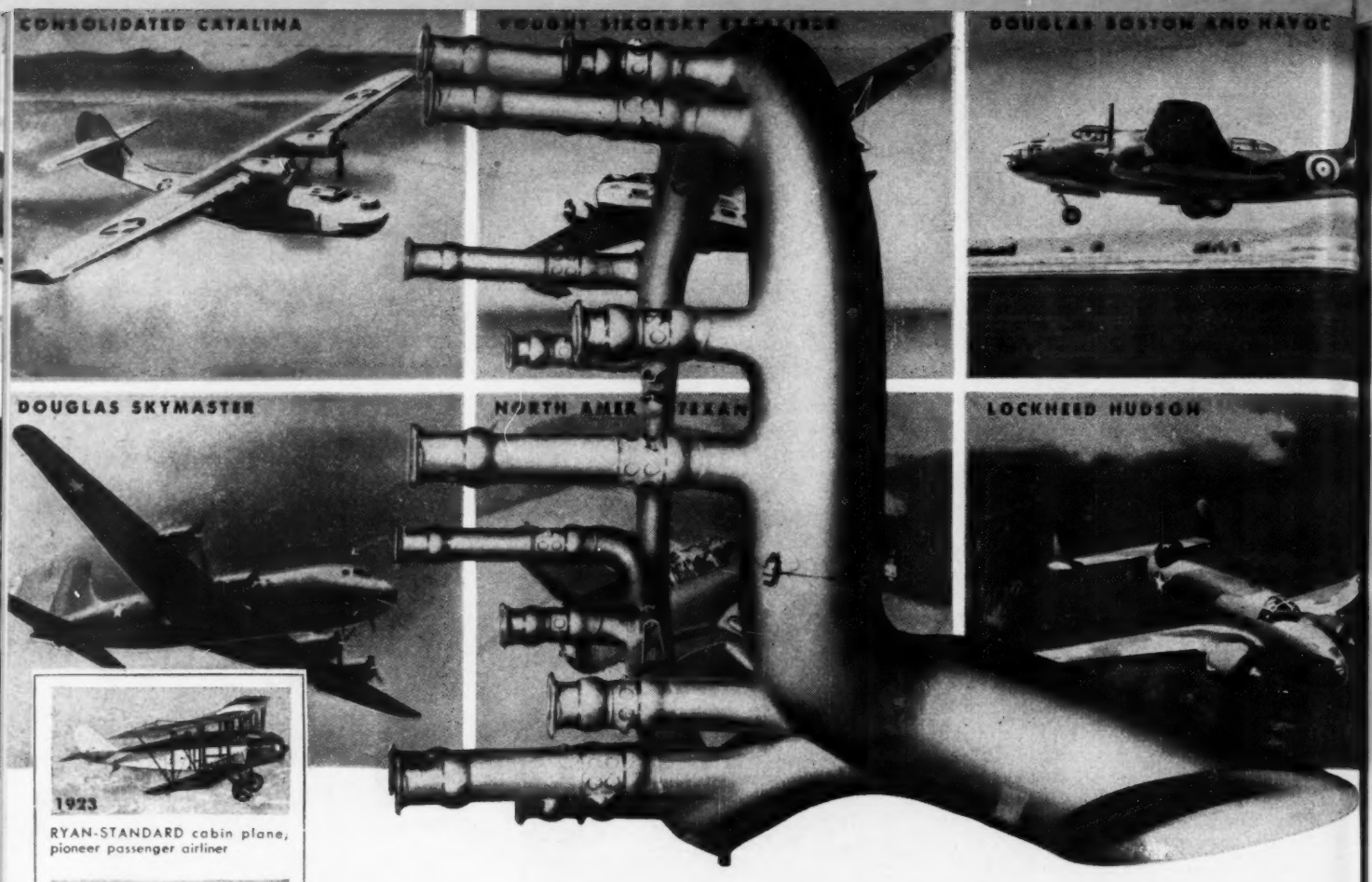
• United Air Lines' central base at Cheyenne, Wyo. uses this jig for rigging tail surfaces. It is made from two plates of 1020 steel with 5/16 O.D. tube braces. Clamped to the elevator torque tube bearing supports, the device enables settings to be checked against one another and results in considerable saving of time. The jig was designed by Nicholas Barber of United's central maintenance base.





Pan American Engine Overhaul Stands

• Movable engine repair stands built by Pan American for Wright radials. They are wired with plug-in connection and two flexible joint extension lights which can be placed in any position for best vision. Side platforms hold tool benches with drawers, providing working surface and making tools accessible. These also are used to reach upper parts and can be moved where desired. Screw jack locking attachment keeps the stand from rolling.



RYAN-STANDARD cabin plane, pioneer passenger airliner

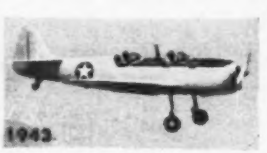
RYAN BROUGHAM, widely used commercially and for many famous flights.

RYAN S-C, cabin plane for private-owner use, featured all-metal construction.

RYAN YO-51 "Dragonfly", Army observation plane with unique performance ability.

RYAN NR-1, low-wing trainer used for formation flight instruction by Navy.

RYAN ST3-S, seaplane trainer of same series as Army's PT-22.



RYAN PT-25, superbly engineered plastic-bonded plywood trainer.

Proud Wings *for the Ryan Manifold*

Ryan Exhaust Systems control and convert to *new practical uses* the intense heat of the roaring exhaust fire of thousands of aircraft engine horsepower. That Ryan both *designs* and *builds* well is attested by this fact: The airplanes on which Ryan Exhaust Systems are standard equipment comprise a list of America's most successful military and commercial types. Six of these are pictured above.

Engineering and research departments at Ryan are responsible for some of the most important technical developments in the exhaust systems field. A procession of other improvements, refinements and new and ingenious solutions to exhaust systems problems, are now coming from the Ryan development section.

Ryan designs and manufactures manifolds, turbo-supercharger installations, heat transfer units for carburetion, cabin heating and wing anti-icing, and flame dampening and other specialized exhaust system applications. Ryan's design and development groups now serve the Army, Navy, and all aircraft manufacturers producing for the armed services.

EXECUTIVES AND TECHNICIANS of firms holding prime airframe and engine contracts can obtain a copy of the new restricted, photographically illustrated publication, "Ryan Exhaust Manifolds" by forwarding proper credentials to either address below.

RYAN

Rely on Ryan to Build Well

RYAN BUILDS WELL

Ryan construction, proven in aviation's pioneer days, now proven in war, will tomorrow produce safer, more useful peacetime aircraft.

RYAN TRAINS WELL

Ryan School of Aeronautics, famous peacetime air school, now training fine U.S. Army pilots, follows one creed: **Thoroughness.**

RYAN PLANS WELL

Modern engineering **+ flying experience.** Typical result: Ryan exhaust manifold systems are now used on the finest planes of other manufacturers.

RYAN AERONAUTICAL COMPANY — MEMBER, AIRCRAFT WAR PRODUCTION COUNCIL, INC.

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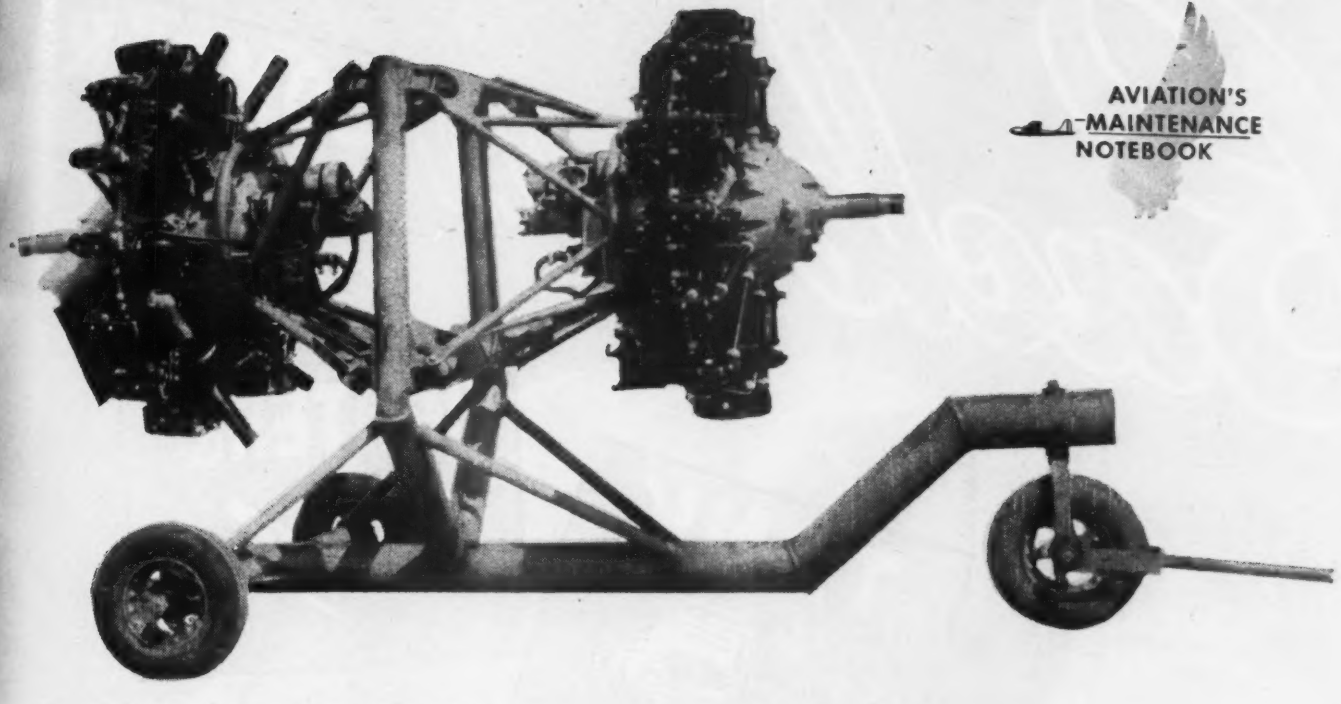
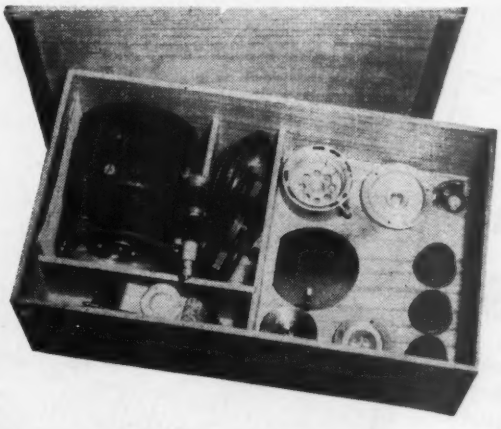
Ryan Products: Army PT-22s, Navy NR-1s, Army PT-25s; S-T Commercial and Military Trainers; Exhaust Manifold Systems and Bomber Assemblies



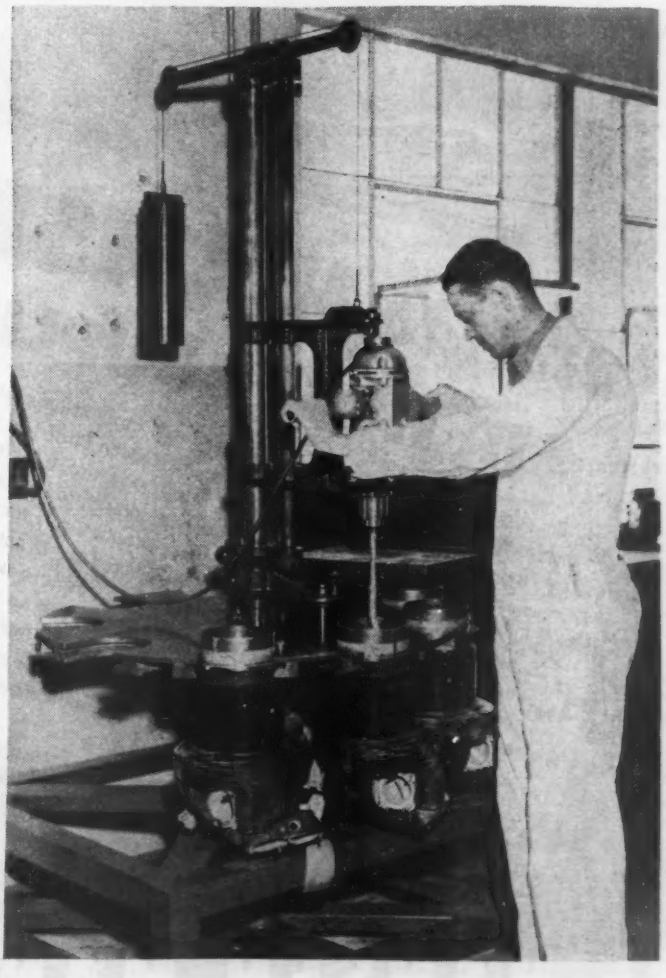
Engine Dolly by Aircraft Repair, Ltd.

• Built to carry engines from assembly to test cells, this dolly accommodates two engines at a time. When engines are attached, mounts are already fastened to the dolly. At test cell engine and mount are removed as one and attached to test stand. Construction is inexpensive, unit was designed and built by Aircraft Repair, Ltd. in Edmonton, Canada.



Gyro Horizon Parts Box at TCA

• Designed to keep the parts of any individual unit together if, during overhaul, work has to be stopped for any reason. Parts can be put in place without damage or danger of being mislayed, until work can be resumed by man who started it. Designed by Instrument Shop Foreman Bruce Saunders, TCA Winnipeg.



Chicago & Southern Cylinder Honer

• With stations for a full set of Cyclone cylinders, the circular table of this fixture is mounted on Timken bearings, rotates cylinders successively into position under honer, is locked in place by indexing pin. Hone is by Sunnen Products Co., is driven by Black & Decker drill ¾ in. Weight and cable counterweight balances the drill for easy vertical movement.

Back of that BOMBER
FIGHTER
TANK
SHIP
stands HANSEN
AIR HOSE COUPLINGS
Backing up the attack on production records in aviation plants, tank arsenals, shipyards, yes in most industrial plants, is Hansen Push-Tite air hose couplings. • First choice because they're easier to operate, much faster, save time, effort, air and money and with that they greatly increase production. • A slight push of plug into coupling—it's connected, air is automatically turned on. Easy pull on outside sleeve, it is disconnected, plug is ejected, air is automatically turned off, absolutely no wastage of air, no leakage. • Complete swivel action eliminates the customary kinking of hose. • They can be used on air, oil or grease lines, • Hansen Push-Tite air hose couplings have earned their remarkable popularity on performance and in many cases have paid for themselves in "air savings" alone. • Send in for free catalog covering our complete industrial air line equipment.
HANSEN MFG. CO.
THE HANSEN MANUFACTURING CO.
1786 EAST 27th STREET • CLEVELAND, OHIO

remember The Horse-Shoe Nail?

"All for the want of a horse-shoe nail . . ."

So goes the old story of battles and empire lost for want of a small but important thing. In today's battles—with history's course depending upon whether a machine functions—mites do make might.

An important part of a famous British gun carrier is the pin which holds track sections together. This modern "horse-shoe nail" must stand up under punishment if the weapon is to serve. Nearly two years ago the engineers of Victor-Peninsular Division of Allied Products Corporation began experiments to cold-head this important part. It posed a tough problem: Nearly 10″ long, the case-hardened pin had to be kept perfectly straight through all operations.

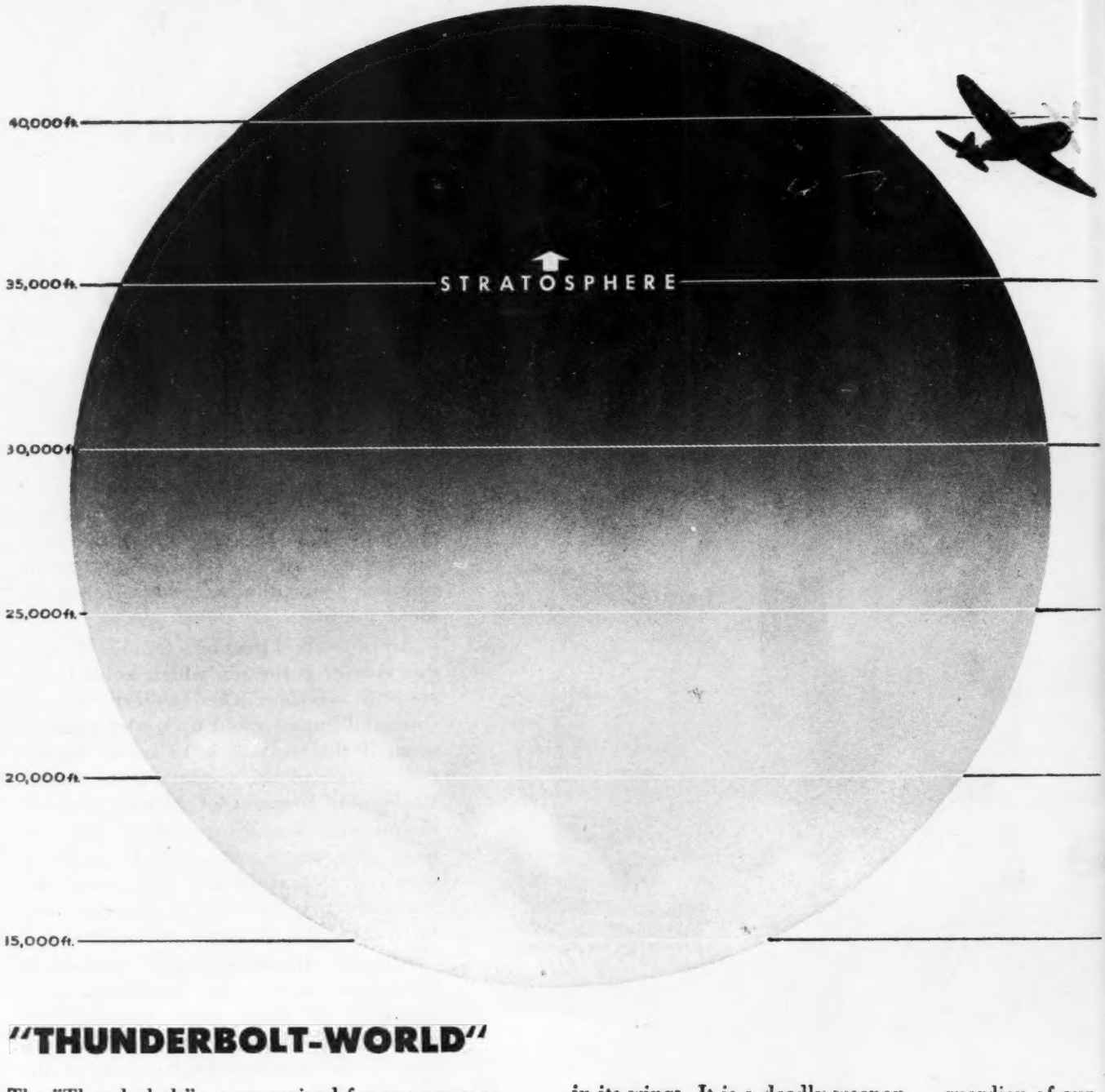
Allied's experience and specialized equipment solved the problems. Now millions of these pins bearing the stamp of Victor-Peninsular are in service on the toughest fronts—best of all, the Allied-made pins *raised the life of the part more than 10 times!*

ALLIED PRODUCTS CORPORATION

DETROIT AND HILLSDALE, MICHIGAN

"IT'S AN ALLIED PRODUCT!"

Parts produced in the four plants of Allied Products Corporation — precision machine parts for aircraft, punches and dies, plastic molds, cap screw and cold-headed parts—are proving the benefit of Allied's skill, experience and facilities.



"THUNDERBOLT-WORLD"

The "Thunderbolt" was conceived for one purpose... to fight in the Stratosphere.

There, over seven miles straight up where few other aircraft go, is the "Thunderbolt-World." Ordinary planes that perform brilliantly at lower altitudes, lose their speed and maneuverability as they approach the Stratosphere.

Up between thirty and forty thousand feet, the Thunderbolt flies at more than 400 miles an hour... spits sudden death from eight 50 calibre machine guns in its wings. It is a deadly weapon... guardian of our high-flying bombers.

Only by experience and scientific research in the Stratosphere and its effect on motors, parts, materials and man himself could such a plane have been engineered. Republic designers and Army Air Forces experts have a rare understanding of Strato-mechanics.

After the war, this knowledge will be used to speed up communication between nations... to bring the peoples of the earth closer together.

REPUBLIC P-47 THUNDERBOLT

ARMY NAVY
FARMINGDALE DIVISION

REPUBLIC Aviation

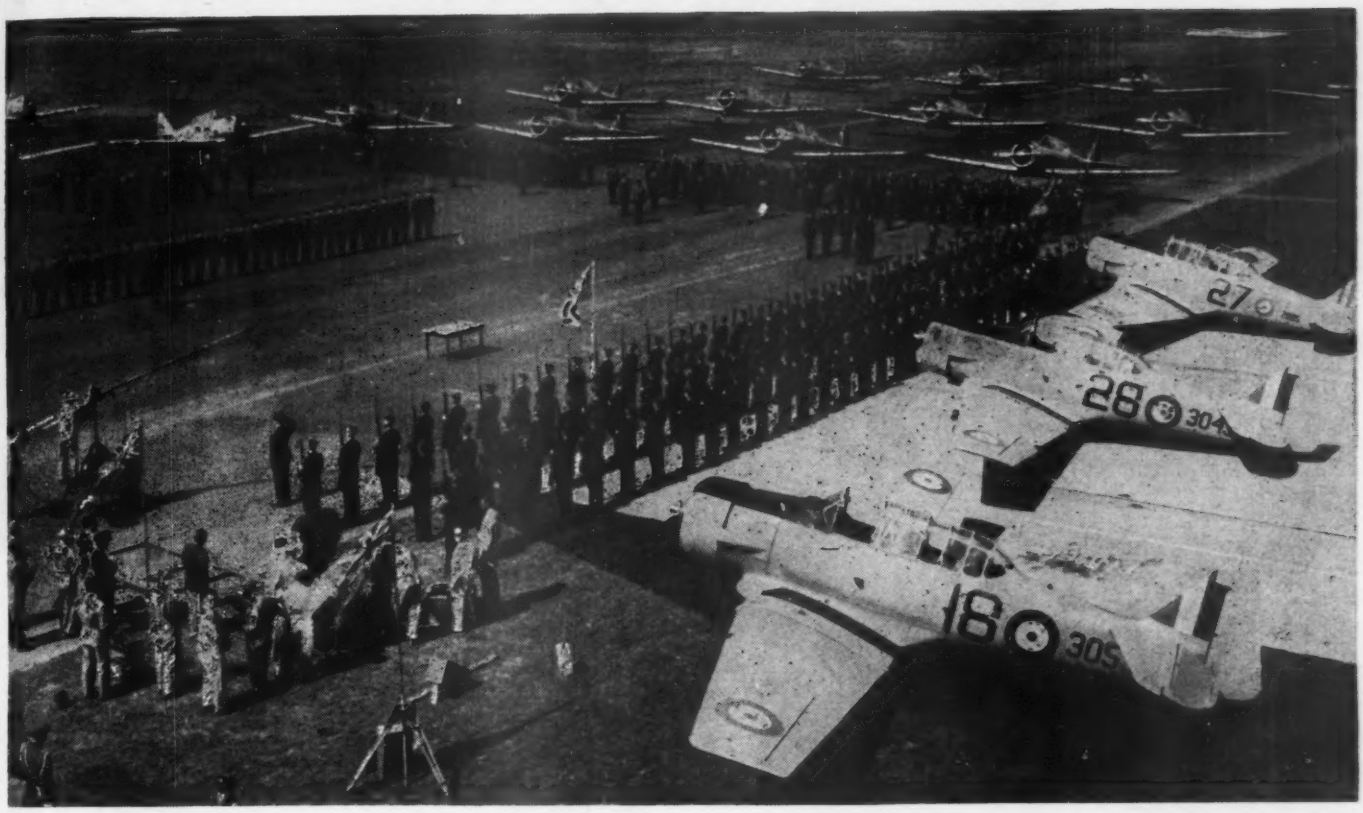
SPECIALISTS IN HIGH-SPEED AIRCRAFT

Canada Trains Them By Tens of Thousands

By JANET R. KEITH

MILITARY

Billion dollar program operates 154 schools—many double the normal size. And already these schools have sent more than 130,000 air and groundcrew graduates to battle.



Under rapidly accelerated and expanded Combined Training Organization which supplies airmen for the United Kingdom, Canada sends thousands of highly trained men overseas each month. Here class lines up for wings presentation. (RCAF photo.)

CANADA HAS BEEN CALLED the fledgling nest of British flyers, an airdrome of democracy, and a training field of United Nations. To a marked degree she deserves all those titles.

Under the urgency of war she has advanced her flying training from a handful of civilian clubs in 1939 to a country-wide network of schools and flying stations. Her aviation organization takes in the youth of many countries and turns out thousands of highly trained airmen every month. It cost better than $1,000,000,000 to bring it to its recently reached full fruition; it is costing close to $500,000,000 a year to operate.

It has in operation today 154 training schools, many of double normal size. To date 130,000 graduates of the training organization have proceeded from its establishments to duties in the British aerial war machine. Of these, 50,000 were aircrew and 80,000 groundcrew. Included in that number are Englishmen, Australians, New Zealanders, Newfoundlanders, Norwegians, Poles, Czechs, Belgians, Americans, and Canadians.

Canada's Combined Training Organization, or CTO., had its beginning in Oct., 1939. Great Britain, Australia, New Zealand, and Canada decided to pool portions of their aviation funds to create an air training system for British Empire groundcrew and flyers. As a location for the scheme, Canada had special values. She had great open areas of sparse population; her war record in the last conflict proved her sons eminently suited to aviation; her nearness to the huge production of the United States promised supplies; and mainly, her removal by 3,000 mi. from the bases of enemy bombers gave safety.

In the leisurely vein of the war of nerves in 1939 and early 1940, the four participating countries readily adopted a program that would bring the training system to maturity in two and a quarter years. They judged that the training of personnel and the hacking of airfields out of fields and forests would take that long.

But Hitler's power-play advance through France blew their schedule wide open. As invasion of the British Isles seemed imminent, Canada offered to send over her flyers then in training to become instructors. Britain said no. She stated that despite the crisis she would prefer them to come in thousands later rather than in tens then. But she asked for acceleration.

Thus, from the summer of 1940 on,

It's four years old. Back in 1939, Bendix engineers began experimenting with plastic poppets* for hydraulic check valves . . . a bold step when dural poppets and hardened steel seats were universally used. After many months of development, of proving and re-proving, of half-million cycle life-tests on a single valve . . . Bendix check valves were offered to the aviation industry and accepted. 1943 finds Bendix plastic poppet check valves on every fighting front . . . in service on more than 20 military airplanes including the P-38, the B-17, the B-24, and the A-20. They are approved as AN-6207-4-6-8-10 & 12 and by the Society of Aeronautical Weight Engineers. The leadership which they have attained today has proved the soundness of Bendix engineering. Complete engineering data on Bendix check valves will be sent on request to airframe engineering personnel. *Bendix Aviation Ltd., North Hollywood, California. Sales Engineering Offices in St. Louis, Dayton & New York.*

*An exclusive Bendix Aviation, Ltd., development, U. S. Patents Pending.

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Bendix

DESIGNERS AND MANUFACTURERS OF RADIO AND HYDRAULIC EQUIPMENT — OUR PART OF THE INVISIBLE CR

acceleration became the keynote. Construction companies, contractors, builders, aircraft producers, executives—all were inspired to hard work by the fall of France and the Battle of Britain. All could see that upon air power rested the fate of the cause. They put forth a truly all-out effort, and as a result the organization reached the status originally planned by mid-1941—a good year ahead of time.

It has continued to expand and, very recently, it reached what is said to be its ultimate size.

How the CTO. has been financed, how it has developed, and what form its future progress will take were discussed recently in the Canadian House of Parliament by Hon. C. G. Power, minister of the air division of the national defense department.

Discussing costs, Mr Power's statements can be summarized as follows:

CTO. expenditures are running currently at about $10,000,000 monthly. On this basis—with no allowance for further expansion—cash requirements for 1943-44 would be approximately $480,000,000. The amount of cash requirement for 1943-44 is stated as $445,335,845, it being considered that Canada will stand to benefit by United Kingdom contributions to a somewhat greater extent than heretofore because of greater deliveries of aircraft and supplies for British account being expected in 1943-44 from the United States and Great Britain. Also, capital expenditures are expected to decline in 1943-44.

There is a great difference between the original financing plan and that now in effect. Changes resulted from the air training conference in Ottawa (June, 1942) at which the U. S. government and Air Forces were represented.

Main points of the original agreement signed in 1939 were these: (1) Canada paid for the recruiting, manning and all RCAF aircrew training up to the stage of advanced training, these same costs being borne by New Zealand and Australia in respect to the aircrews of those dominions, which subsequent to such training were sent to Canada for advanced training; (2) United Kingdom supplied all twin-engine aircraft, except *Anson* wings, a certain number of single-engine aircraft, and half the engines for

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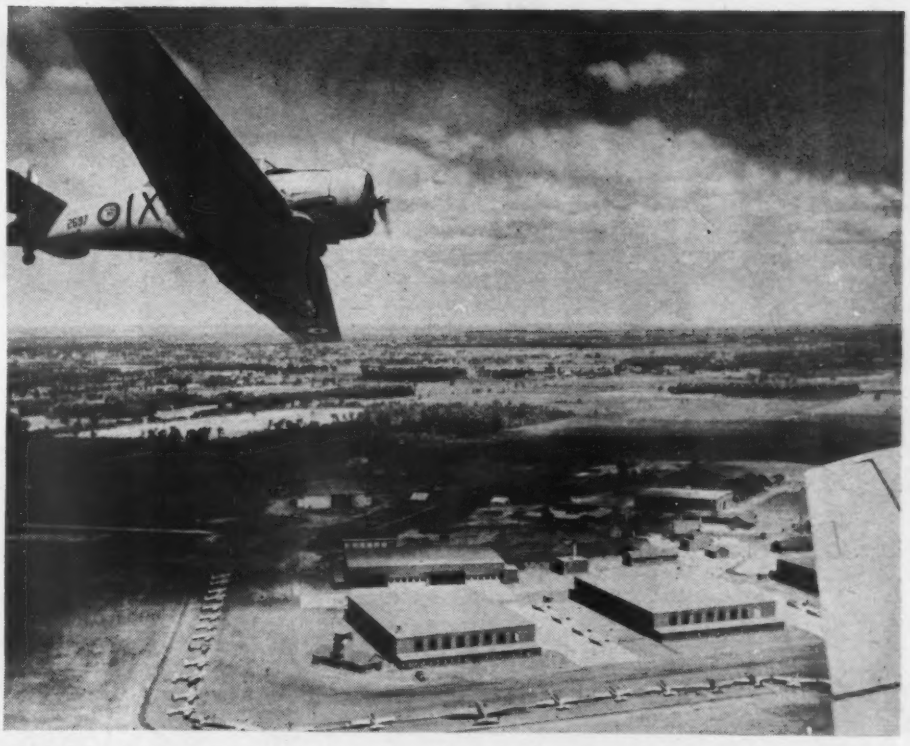
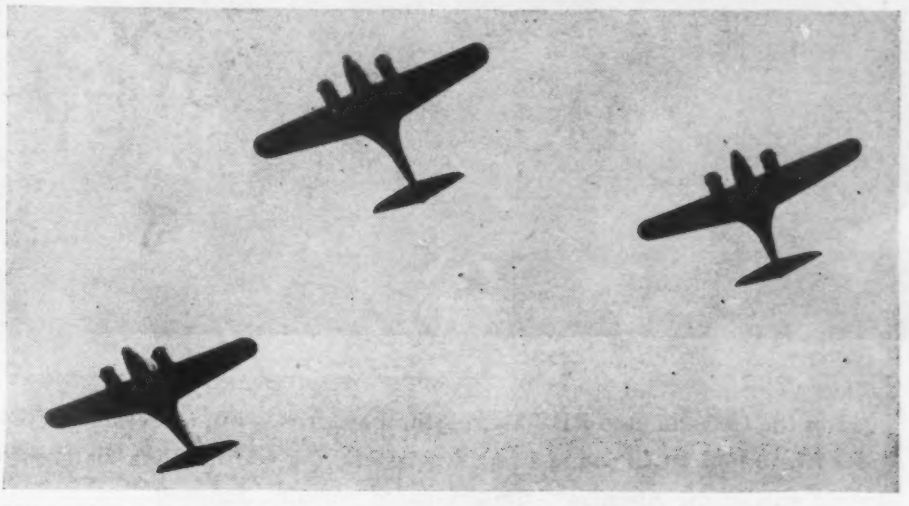


Canada's chain of air schools spans continent, with many units enlarged to twice normal size. Typical of such units is that above, with North American *Harvard* circling field.



Quality is stressed by CTO even more than quantity. These Avro *Ansons*—team-mates of Cessna *Cranes*—give both navigators and pilots coordinated training in cross country flights. (RCAF photo.)

Pictured are key men who, with other United Nations representatives, formulated future flight training program at Ottawa conference. Left to right: Maj. Gen. Barton K. Yount, Commanding General, AAF Training Command; Rt. Hon. H. H. Balfour, British Parliamentary Under Secretary of State for Air; Maj. Gen. T. H. Shen, Commander of Chinese Air Forces in the U. S.; and Maj. Gen. L. H. van Oyen, Royal Netherlands Indian Army.

Not Fit FOR MAN OR BEAST...

Official Navy Photograph

... But the Consolidated PBY Patrol Bomber turns up a frosty nose at the wind-swept wastes and fog-bound seas of the Aleutians! Smarty-pants pursuit pilots might think her slow. But many a sea-venturing Nip or Nazi has found her an on-coming arrow followed by a shattering explosion, and then . . . a lean, red individual with horns hands him a shovel.

Despite PBY's duckish appearance alight, in the air her powerful streamlined length delights the eye . . . nine tons of amphibious warship, well-festooned with bombs, built to serve at Pole or Equator . . . the "work-horse" of the Navy! Maneuverable? Read in today's papers about sub-straddling bombs, oil-slicks, or enemy transports blasted!

Chalk up these fine points of maneuverability to Fafnir Ball Bearings on the controls. Translate them into years of collaboration between Fafnir engineers and the nation's aircraft designers. There you have a picture of the precise, responsive, all-climate performance of Fafnirs . . . and an inkling of service Fafnir Ball Bearings can render in coming days of peace. The Fafnir Bearing Company, Aircraft Division, New Britain, Connecticut.

ARMY (E) NAVY

Send for copies Fafnir Aircraft Service Manual, you will find it an invaluable service guide.

FAFNIR
Ball Bearings
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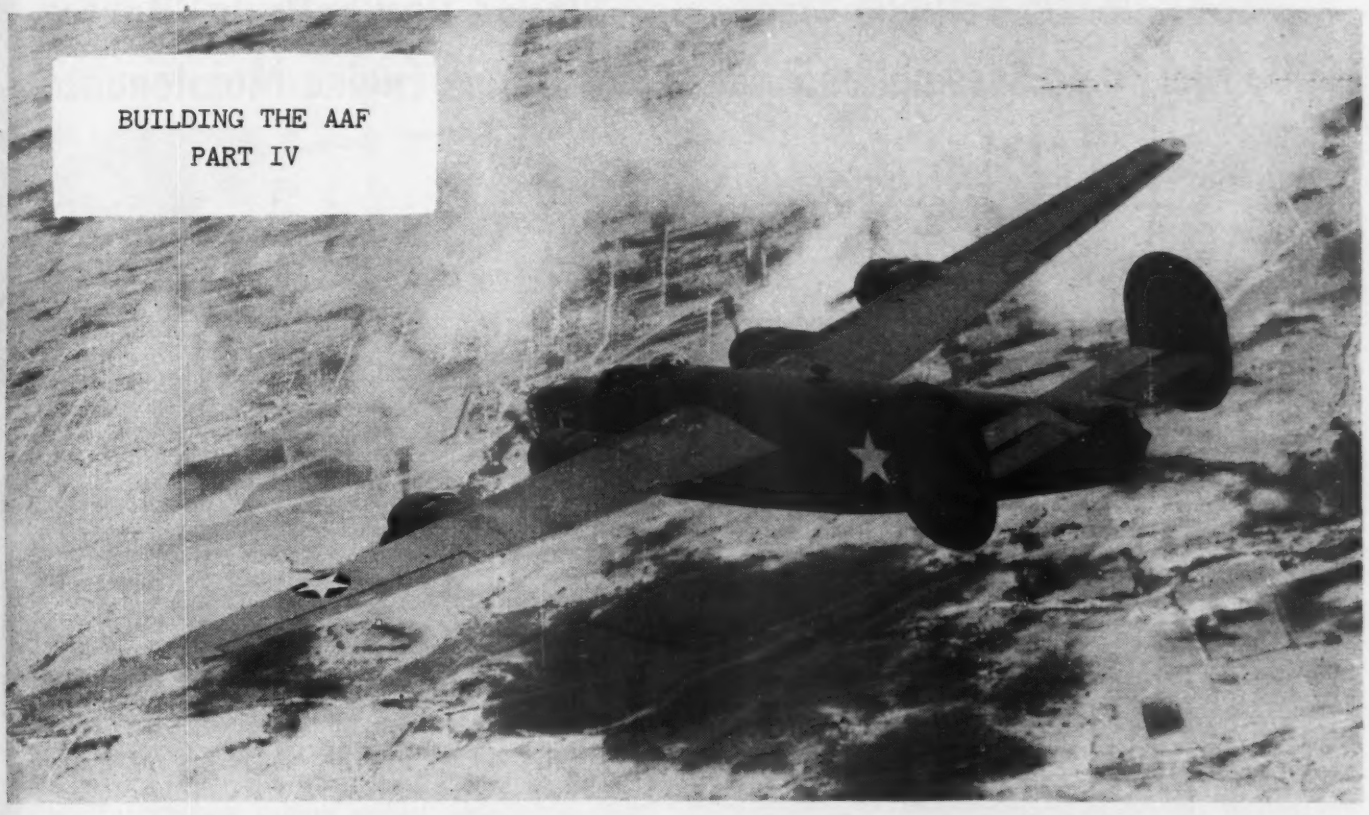
Engines and Controls

Piloting Big Bombers Is Big Business

MILITARY



From Training Command's Tarrant Field, future *Liberator* flyers head out over Texas to get the feel of four engines hurtling some 20 tons of plane. Banks, turns, glides and safe maneuvering on two engines—are part of the piloting curriculum.

Nine weeks in cockpits, classes, and mechanic's overalls won't make a four-engine pilot. A man also has to have the executive's skill for management plus "the ability to think of 50 things at once."

DOWN IN TEXAS in a lakeside setting a stone's throw from one of the world's greatest plane plants, the Army Air Forces Training Command is bringing out the "big business" instinct in pilots who would fly the Consolidated Vultee four-engine B-24 *Liberator* bomber.

The job here at Tarrant Field, as at other AAF four-engine transition schools in the nation, is to create combat crew leaders with responsibility over the lives and efficiency of ten men and a $250,000 "flying battleship."

In a nine-weeks' course that sends the student officer into both the classroom and the air on a round-the-clock schedule, the "lone eagle" pilot becomes a flying executive whose staff is the crewmen and whose office is the fuselage of one of the world's most potent airplanes.

The bomber pilot is the "finger" and the "brain" of a closely-knit unit and must always be conscious of his relationship to a group of comrades whose destinies—successes or failures—are inseparably interdependent.

When the student—who may be anything from a second lieutenant to a lieutenant colonel—realizes his enormous responsibilities, the transition school's task is more than half done.

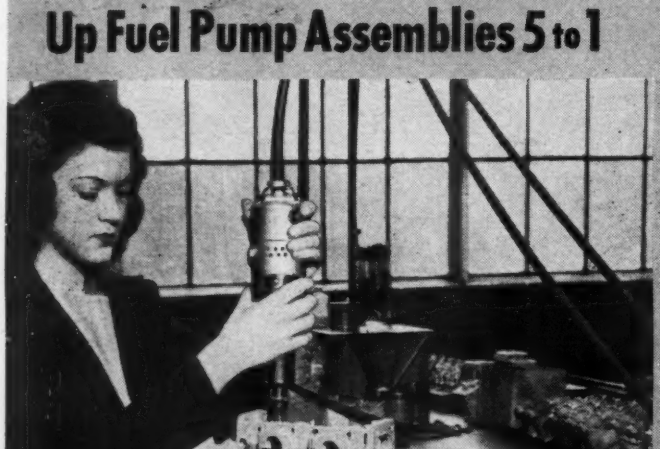
The B-24 pilot learns to lift his huge craft into the skies with efficiency—not dash. Besides being pilot he is also engineer, mechanic, coordinator of several score pre-takeoff checks and tests, safety expert, leader, and general manager.

Typical of the veteran flyers who direct Tarrant's stiff training routine is Maj. Albert L. Haley, 25-yr.-old squadron commander who won his wings at Kelly Field. "Not every pilot can handle the *Liberator*," he says, "for obviously not every man can think of 50 things at once—and still fly an airplane. There are countless flyers, top-notch in single-engine planes, who are prevented by disposition or temperament from taking charge of the B-24."

Before the big plane's captain ever taxis off the ramp, he is required to make, or oversee, 40 individual checks. With the assistance of his co-pilot and his enlisted engineer, he inspects the crew, engines, fuel, gas tank caps, brakes, wheel chocks, wing flaps, bomb bay doors, and the readings of a complexity of instruments that would do justice to the control center of a heavy cruiser. After the engines are started, 9 checks are made before taxiing; 8 more after the *Liberator* is headed for the taxi-strip; 15 before the actual takeoff; 2 more when the plane is in the air; and 5 when it reaches cruising altitude. Before landing, 19 checks are made. There are 6 more immediately after landing, plus a final 13 later to secure the ship on completion of its

for Both PRODUCTION and MAINTENANCE

Black & Decker Scrugun Steps Up Fuel Pump Assemblies 5 to 1



"We use a Black & Decker Scrugun for the precision job of assembling body and housing of airplane fuel pumps," reports a large pump manufacturer. "We find the Scrugun speeds production 5 to 1 over hand tools. The sensitive clutch provides a more uniform torque for uniform assembly pressure—and women can use these Scruguns on jobs impossible for them to do with hand screw drivers."

Black & Decker Drills Vital for Airplane Engine Maintenance

Whether the job calls for honing airplane engine cylinder walls (right) or for dressing engine valve seats (left), this leading airline's service shop crew would be lost without the help of Black & Decker Maintenance Tools. Black & Decker Electric Drills, Valve Seat Grinders and Valve Refacers are "musts" in military and commercial air bases and maintenance shops everywhere.

The Aircraft Industry Depends on Black & Decker Tools "PLUS" Service

These two cases are typical of the hundreds of airplane production and maintenance jobs Black & Decker Portable Electric Tools help do *faster and better*. Men who build and maintain aircraft depend on them in the production of parts, assemblies, sub-assemblies, engines, armament . . . and for all sorts of airplane maintenance jobs. They depend on Black & Decker "plus" services, too—coast-to-coast Factory Branches for quick, expert tool repairs and replacements . . . convenient interchangeability of parts . . . close-at-hand Distributors for help on today's production problems and tomorrow's retooling programs. It will pay you to keep posted on Black & Decker in your postwar planning. The Black & Decker Mfg. Co., 738 Penna. Ave., Towson-4, Md.

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Atlanta, Ga.; Baltimore, Md.; Boston, Mass.; Buffalo, N. Y.; Chicago, Ill.; Cleveland, Ohio; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Indianapolis, Ind.; Kansas City, Mo.; Los Angeles, Calif.; Memphis, Tenn.; Minneapolis, Minn.; Newark, N. J.; New Orleans, La.; New York, N. Y.; Oakland, Calif.; Philadelphia, Pa.; Pittsburgh, Pa.; San Francisco, Calif.; Seattle, Wash.; St. Louis, Mo.; Towson, Md.; Toronto, Ont.; Montreal, Que.

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PORTABLE ELECTRIC TOOLS

flight. The passenger is left with a definite conviction that the four-engine pilot is no carefree birdman but a methodical and highly skilled technician.

To make him such there is great emphasis on ground school subjects. The student officer must thoroughly learn the inner workings of his plane preparatory to assuming broad obligations in the attainment and maintenance of perfect mechanical performance. The smooth synchronization of power available from the B-24 is dependent to a large degree on the pilot's understanding of the problems involved in its structures and engines, with considerations of the feelings and skills of his crew. Because it is his task to supervise the work of his men, the pilot must have a precise understanding of their respective duties. To learn the problems which confront his ground crew, he makes practice repairs with his own hands. If damage occurs because of his error, the guilty pilot is required to do much of the repair work himself.

In ground school he also studies wing and tail assemblies, superchargers, brakes, retractable gear apparatus, airframes, engines, and propellers. He first meets the eye-filling instrument panel in class, where a complete replica has been installed.

Further, he is required to freshen-up his technique in code and visual message sending and receiving, while renewing his ability to identify scores of naval vessels and aircraft types. The principles of avigation, learned by the student as cadet before he won his wings, are reviewed, and the *Liberator* learner is made aware of the important role the pilot plays in maintaining constant speed and heading for the benefit of the navigator.

Actual B-24 transition flying is begun, of course, during the daytime when the student officer gets his first introduction to the inside of the *Liberator's* cabin. Then come taxi trials, takeoffs, banks, turns, glides, climbs, spirals, stalls, and landings. Before his record sheet is finally signed by his squadron commander, the *Liberator's* future manager masters a number of emergency procedures and learns to fly his plane safely on three engines, also on two. And before leaving for the Operational Training Unit—his last stop before combat—he flies at night on instruments only, in battle formation, and at altitudes well above 30,000 ft. with oxygen equipment. The final examination is a long cross-country hop.

His training completed, the four-engine pilot represents the world's finest "eager beaver" of the airways.

In the words of Training Director Major Haley, "He's more than a pilot. In our AAF he stands for everything human that it takes to tear out the heart of an Axis city."

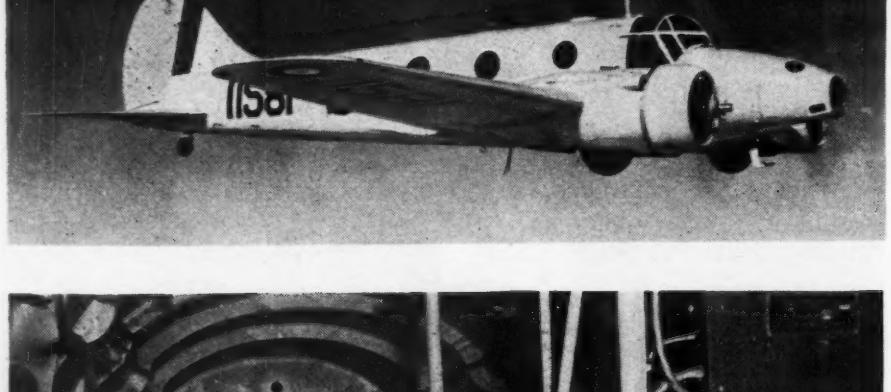
From "contact" to checkout, the pilot and his mate must make 77 inspections of instruments and apparatus.

A "big business man of the air," the *Liberator* pilot is chief executive over a $250,000 plant and ten men who collectively pack a four-ton punch.

FLYING EQUIPMENT

"Old Lady In a New Dress"

Avro "Anson V," re-designed to meet Canadian conditions, completes evolution from prewar light bomber to avigation trainer for RCAF and RAF.



Evolution of a trainer. An early Avro *Anson* (above) when the type was classed as a combat craft, and (below) today's re-designed version on duty in Canada as an avigation trainer. Glass-enclosed tubular structure has given way to molded plywood fuselage much better adapted to Canadian winters. Gun turret has been replaced by less bulky astro dome, and Pratt & Whitney engines have been substituted for difficult-to-obtain *Cheetah* engines.

NOW GOING INTO PRODUCTION at Federal Aircraft in Canada is the Avro *Anson V*, newly accepted twin-engine avigation trainer which was developed from the *Anson II* that had been used as a transition trainer by the Royal Canadian Air Force.

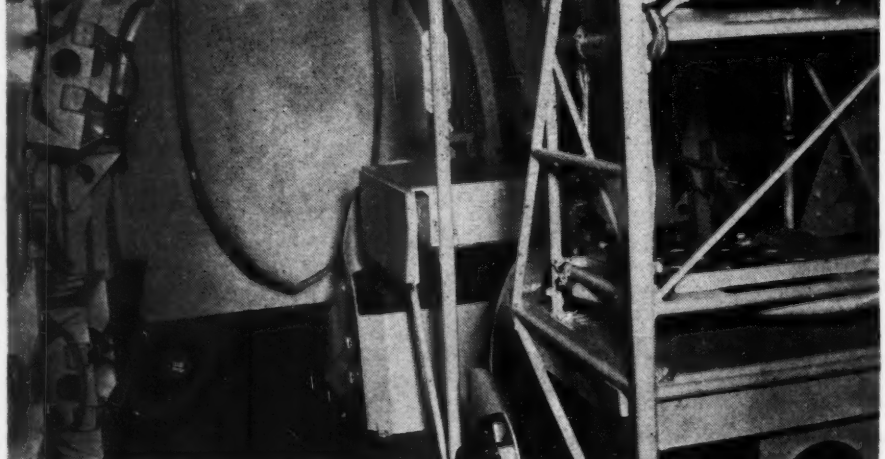
Principal changes are in the fuselage and in substitution of 300 hp. Pratt & Whitney *Wasp Junior* engines for the now difficult-to-obtain British-built *Cheetahs*. Mid-section of the fuselage is of plastic bonded plywood of improved streamlined shape in place of the former tubular glass-enclosed structure. In addition to improved performance, the use of plywood is expected to facilitate production as well as to make material savings in strategic materials.

These changes have been brought about by dual factors: A change in the *Anson's* function and the need to conserve both materials and man-hours. Prime duty of the *Anson II* was dual flight training with crews of two or three on local flights; today's version is used almost exclusively as an avigation trainer, carrying a crew of four or five on three to four-hour flights.

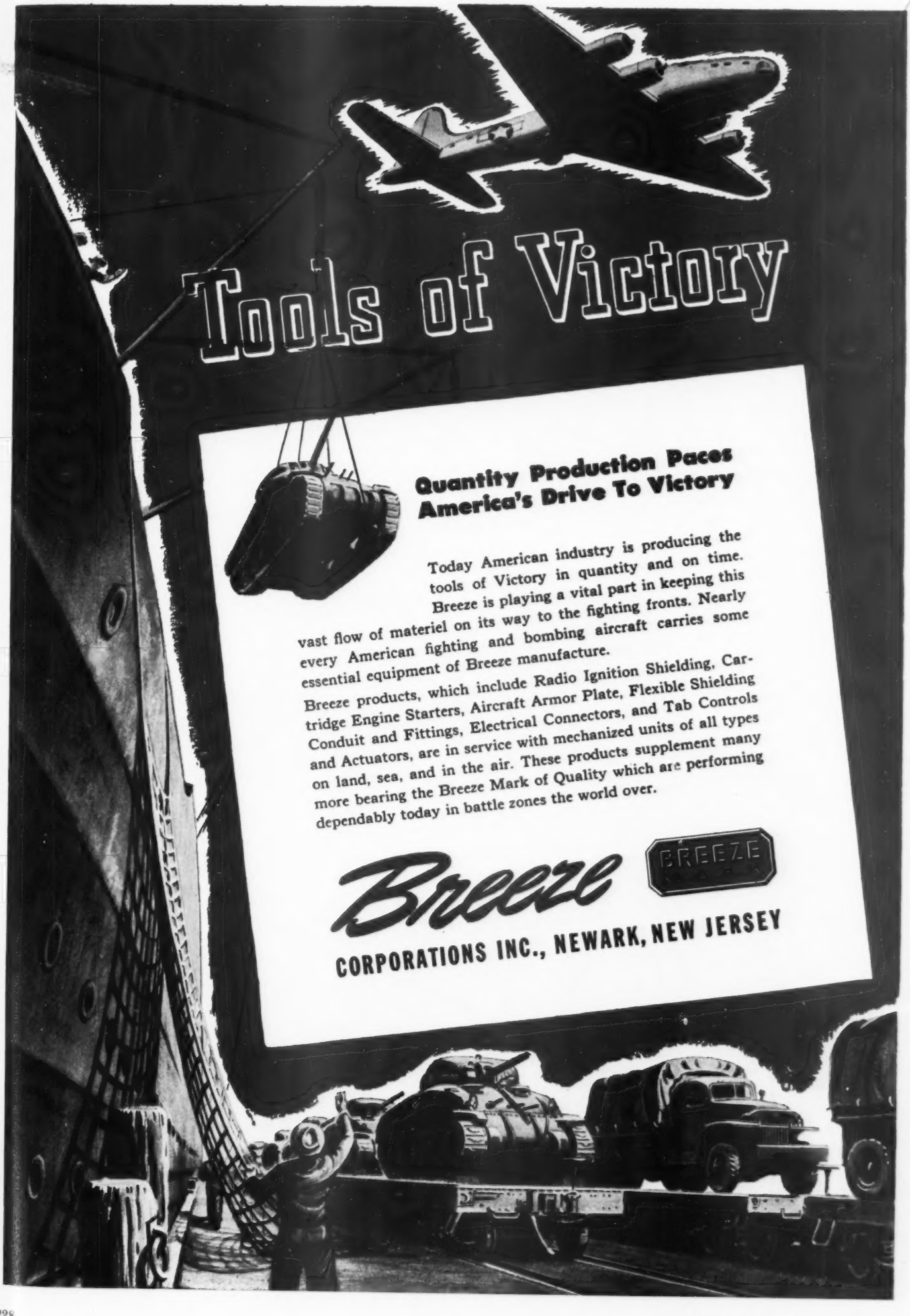
Comparative specifications and performance data follow:

	Anson V	Anson II
High speed	200 mph.	180 mph.
Cruising speed	120–165 mph	120–140 mph.
Landing speed	66 mph	63 mph.
Stalling (without flaps)	73 mph.	70 mph
Rate of climb (sea level)	1,600 ft./min.	1,000 ft./min
Gross weight	8,500 lb.	7,650 lb.

★ ★ ★



Re-designed as flying classroom rather than fighting craft, new Avro *Anson V*, Canadian version of British light bomber of prewar days, carries crew of four to five on three to four hour avigation training flights. In right foreground is seen radio operator's installation, behind which is avigator's desk with drop-leaf table. Folding seats for avigator students are at left.


Tools of Victory
Quantity Production Paces America's Drive To Victory
Today American industry is producing the tools of Victory in quantity and on time. Breeze is playing a vital part in keeping this vast flow of materiel on its way to the fighting fronts. Nearly every American fighting and bombing aircraft carries some essential equipment of Breeze manufacture.
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Spadework for Victory

Behind today's spectacular military success is a story of vision and daring that goes back to 1941 . . . to the first high-silica bauxite dug from Arkansas mines for Reynolds plants. For that shovelful of bright earth foretold a great new source of aluminum for America . . . a *domestic* source, immune to the threat of U-boats, unrestricted in quantity, demanding only the right kind of plant facilities to supply the largest and strongest air fleets ever dreamed of.

Reynolds built that kind of plant. Completed in the world-record time of five months and twenty-nine days, it is still the only plant in the country where bauxite comes in at one end and aluminum sheet rolls out the other. What is more, that plant was deliberately planned to process bauxite from good old American soil. This, long before Pearl Harbor . . . may aptly be called "Spadework for Victory."

But Reynolds does not rest upon past laurels. Reynolds takes the lead in prefabricating airplane parts at the aluminum source. Reynolds metallurgists look ahead for new aluminum alloys that will give even greater striking power to Allied airmadas. And Reynolds original skill, as the world's largest roller of aluminum foil, promises still further triumphs in the light-metal age of tomorrow.

The march is on . . . toward *Leadership in Aluminum.*

Actual color photograph of domestic bauxite ore from Reynolds' own mines.

REYNOLDS ALUMINUM

OUT OF THE GROUND INTO THE SKY

REYNOLDS METALS COMPANY • GENERAL OFFICES • RICHMOND, VA. • 38 PLANTS IN 13 STATES

AMERICA'S NEW SOURCE OF ALUMINUM

PV-2 Helicopter Makes First Public Flight

FLYING EQUIPMENT

New craft said to be free of vibration and flutter characteristics through full operation range, including cruising speed of 65 mph. and top of 90-100 mph.

FIRST PUBLIC DEMONSTRATION of the PV-2 helicopter, designed and built by P-V Engineering Forum, Inc., of Philadelphia, Pa., was given last month at Washington National Airport by Frank Piasecki, Forum president. While more than 25 helicopter projects are known to be under way throughout the country, this craft was the second American-built helicopter flown publicly.

A single place craft, powered by a 90 hp. four cylinder Franklin aircooled engine, the PV-2 has a three-blade rotor of 25 ft. diameter. Rotor blades are combination wood and metal construction; the spar being of tubular steel, ribs, leading and trailing edges of wood, all fabric-covered. Chord of the rotor blades is constant at 9½ in. except the tips and approximately 1½ ft. just outside the fairing which covers the rotor control. Spar is 1⅛ in. in diameter at the root, tapering to 1 in. at the tip.

Normal horizontal cruising speed of the craft is approximately 65 mph., with the rotor blades turning at some 350 rpm. for this speed. Range is given at 2 hr. Top speed of the craft is estimated by the designers at from 90 to 100 mph.

Rotor blade pitch variation moves over an arc of approximately 8 deg. for fore and aft control and 4 deg. for lateral control.

Anti-torque, or rudder prop, which is mounted on the right side of the fuselage tail, is of two-blade construction, with a 5-ft. diameter. Geared to maintain a constant speed relationship to the main rotor, it turns between 1,600 and 1,700 rpm. at cruising speed. Directional control is imparted through conventional rudder pedals which change pitch of the anti-torque blades.

The control "stick" for fore and aft and lateral control is suspended from the roof of the cabin with conventional rudders acting on a two-blade anti-torque rotor of 5 ft. diameter to give lateral control.

The PV-2 helicopter differs from others in that pitch control can be set and the craft flown with the thottle. For takeoff, the pitch control is set in forward position and the throttle opened until the craft ascends vertically. To change from vertical to forward motion, the stick is pushed forward, then eased back to about neutral as the craft gains speed. The throttle can then be eased back to maintain cruising speed.

While no details on the rotor controls were divulged, Elliott Daland, chief engineer, reported they are of simpler construction and contain fewer working parts than other drives. The entire unit is housed in what its designers call the "discus", a fabric-covered faired unit some 3 ft. in diameter.

The engine is mounted on end in the lower part of the fuselage immediately behind the pilot with a drive shaft going straight up to the rotor control through a universal joint installed to absorb vibration.

Fuselage is of conventional welded tube construction, faired up over the rotor mount to the rotor hub. The craft is fitted with wheel and tail skid landing gear, the tread on this experimental model being slightly wider than that of any automobile.

Mr. Daland reported that the PV-2 is free of vibration or flutter periods such as those encountered in automobiles when picking up speed in second gear —in changing from vertical to horizontal speed, or when the craft is picking up speed horizontally.

Both Messrs. Piasecki and Daland pointed out that the PV-2 is strictly an experimental craft—which has some 15 hr. flying time—and that no claims are made that it is the answer for the "man in the street." A larger model, said to have a payload of more than a ton and a range of some 400 mi. has already been designed.

Frank Piasecki, president of P-V Engineering Forum, Inc., at controls of PV-2 helicopter, as it hovers over American and foreign military pilots and newsmen during craft's first public demonstration flight at Washington National Airport. PV-2 designers report its top speed at 90–100 mph. and cruising speed at 65 mph. when 25-ft. diameter rotor blades turn at 350 mph. Anti-torque, or rudder rotor blades of 5 ft. diameter turn up approximately 1,600 rpm. at cruising speed.

Performance & Specification Data

High Speed	90–100 mph.
Cruising Speed	65 mph.
Gross Weight	1,000 lb.
Rotor blade diameter	25 ft.
Rotor Blade Chord	9½ in.
Rotor Blade Speed (cruising)	350 rpm.
Anti-torque rotor diameter	5 ft.
Anti-torque rotor speed (cruising)	1,600 rpm.
Power plant	90 hp., 4-cylinder, aircooled Franklin

COWL-ACTUATING JACK TO OPERATE VENTILATORS ON THE P-38
GEAR ASSEMBLY FOR OPERATING LANDING GEAR ON THE AT-21
WORM AND GEAR FOR CONTROL OF GUNS IN TURRETS ON THE B-17

Production of Precision Aircraft Devices

SOLVING intricate production problems called for in the manufacture of high-precision aircraft devices is another contribution Foote Bros. Gear and Machine Corporation is making toward speeding the day of Victory.

Precision gears for reducers for azimuth and elevation control of guns in turrets in the B-17 bombers—gear assemblies to raise and lower the landing gear of the AT-21 trainers—cowl actuating jacks to operate ventilators on oil coolers on P-38 interceptors—all these devices call for light weight coupled with extreme precision.

Foote Bros. engineering experience and manufacturing "know-how" acquired in the production of precision gears in tremendous quantities for Pratt & Whitney aircraft engines assure the production of these special devices in the quantities required to meet the ever-increasing demand of our global air force.

It is natural that many manufacturers of airplanes, airplane engines and airplane parts recognize in Foote Bros. a logical source for gears and devices where light weight and extreme precision are essential.

After the war, the experience gained in the manufacture of such gears and devices promises American manufacturers a new era in the economical transmission of power.

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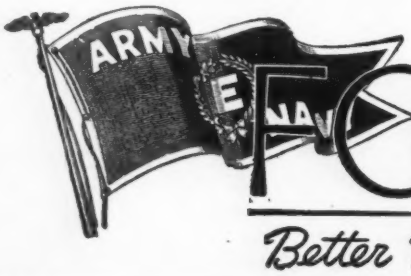


FOOTE BROS.

Better Power Transmission Through Better Gears

CIVIL OPERATION AND TRAINING

On Patrol

• Specifications on complements of officers for various-sized Civil Air Patrol units are being distributed in a revised procedure memorandum which also reduces staff titles to seven: Executive, staff, intelligence, medical, communications, supply, and adjutant. Commanders of large groups, squadrons, and flights who have shown exceptional merit may be promoted one grade higher Promotions may also be made for outstanding performance in smaller groups. "Appointments to functional posts as command and staff officers are on a temporary basis and terminate with relief from such assignments," National Headquarters announces. "However, a procedure is being developed to commission CAP officers for the duration on the basis of aeronautical skill, service, and completion of training courses. Temporary commissions for active duty assignments will be good for 30 days after relief from such duty in order to give time to fit these officers into wing units on return to their home squadrons."

• Recruiting drive for AAF cadets is now being directed at schools. Headquarters recommends that units make contacts with school principals and parent-teacher associations and hold meetings to explain enlistments to prospective candidates. Arkansas and Florida school systems are allowing students credit for completing CAP courses in meteorology, avigation, and maintenance.

• Method of artificial respiration, developed by Dr. L. K. Zimmer, Kansas Wing medical officer, involves strapping victim on a plank or other flat object and see-sawing him up and down. This motion results in pressure of the viscera moving diaphragm, producing, it is reported, 40 percent greater volume of air inhalation

• In Tennessee, the state has agreed to pay part of the expenses—including insurance, gas and oil, and depreciation—of field maneuvers.

Along the Apron

• Among tuition-free engineering and management courses sponsored by an appropriation of the U. S. Office of Education and being given by New York University are twelve covering aeronautics and air transport intended to prepare students for war work. Applications, which must be approved by the government, should be made to the university war training office.

• *Virgil et cetera exeunt:* Ancient history and fine arts have gone by the board at Berkshire School, Sheffield, Mass., to make time for flying and aeronautical ground courses in the regular curriculum. On the point of soloing are Headmaster Albert Keep and some 40 of his undergraduates.

• Flight instructors for contract schools are being trained in 23 additional units activated by the AAF new Eastern Flying Training Command. During an approximate year's course, students enrolled in the enlisted reserve will be given AAF basic and secondary training and instruction in cross country flying, Link trainer, pedagogy, and a final term at Randolph Field. Assignment to contract schools will follow.

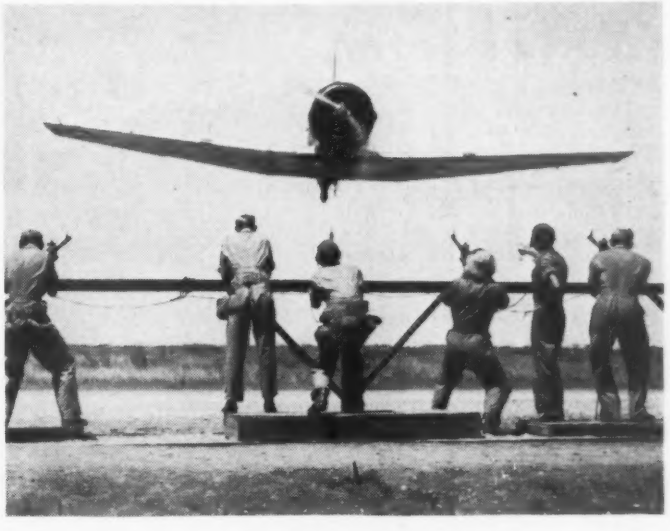
• Trans-Canada Air Lines' largest personnel training class, recently graduated, contained 38 women in a total enrollment of 50 indoctrinated in radio and teletype operation and passenger and traffic duties.

• Piper *Cub* trainer is the subject in a new series of pre-flight training films prepared for educational organizations by Bray Pictures Corp., New York City. Pictures explain elements of aerodynamics and maneuvers. During first month of national distribution, 70,000 people are estimated to have seen the film, *The Construction of a Light Airplane*, made at Piper Lock Haven, Pa., plant by Pennsylvania State College.

• In postwar meteorology "it will doubtless become the practice to disseminate synoptic and prognostic charts from principal forecasting centers by facsimile or other electronic methods of reproduction," William A. M Burden, special aviation assistant to the Secretary of Commerce, predicts.

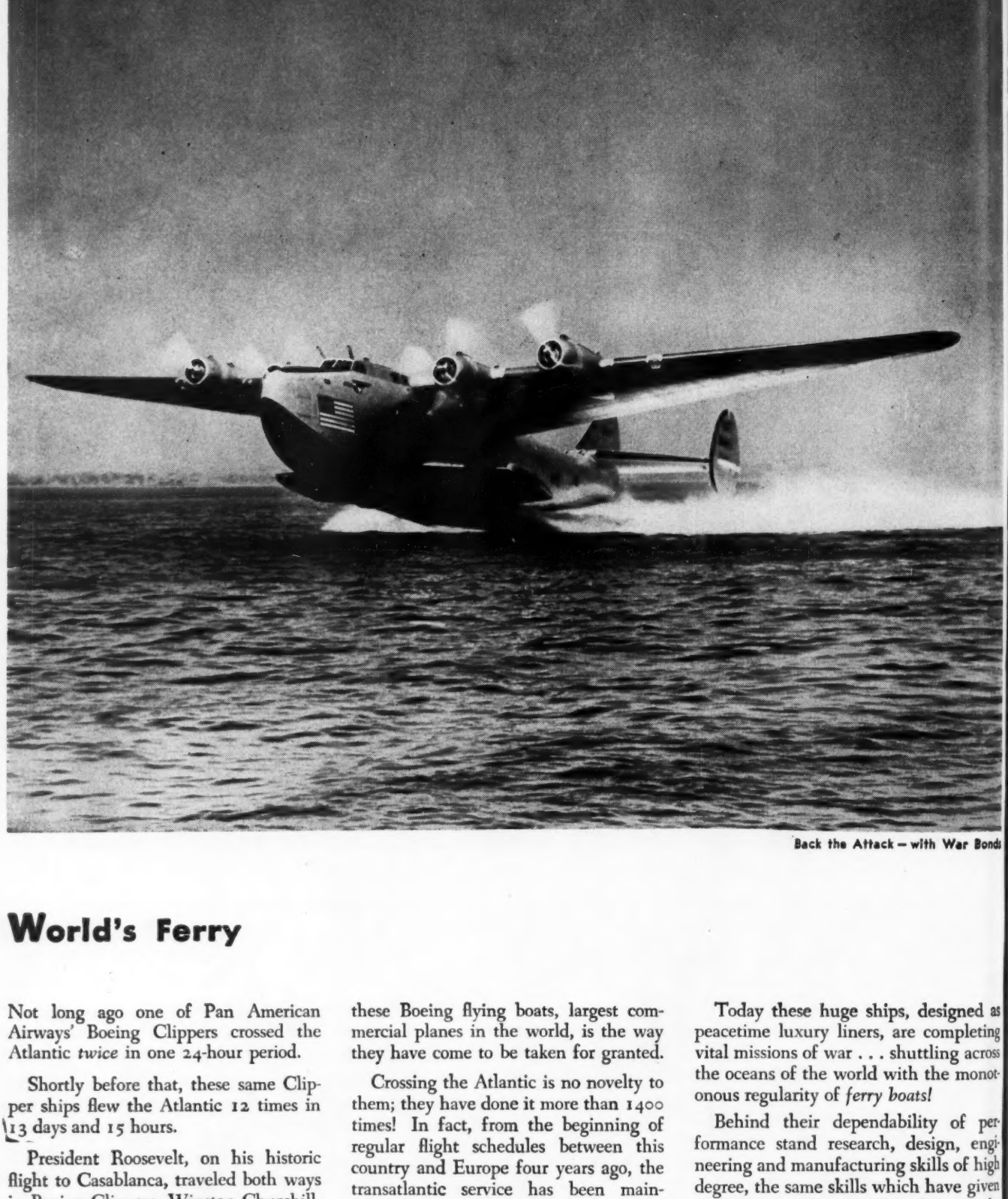
CONTROL BY "FEEL"

Left: So bomber pilots can fly with their eyes continuously on their target, Randolph Field, Tex., school gives them blindfold tests in control operation. On command of his instructor, this student reaches for precise gadgets called for from among scores of instruments and controls studding cockpit. Right: At Harlingen Field, Tex.,



"BEAD PRACTICE"

gunners-in-training take sights on approaching "enemy" just as they will do later on battle fronts—when their turret guns will be loaded with live ammo Here, "attacking" pilot radios his range to gunners, who note size of his plane at various distances and keep beads on it until it passes overhead. (International News photos.)



Back the Attack — with War Bonds

World's Ferry

Not long ago one of Pan American Airways' Boeing Clippers crossed the Atlantic *twice* in one 24-hour period.

Shortly before that, these same Clipper ships flew the Atlantic 12 times in 13 days and 15 hours.

President Roosevelt, on his historic flight to Casablanca, traveled both ways in Boeing Clippers. Winston Churchill, on his trips to America, crossed the ocean 6 times in Boeing-built planes of British Overseas Airways.

These are the high-lights. But perhaps the most remarkable thing about these Boeing flying boats, largest commercial planes in the world, is the way they have come to be taken for granted.

Crossing the Atlantic is no novelty to them; they have done it more than 1400 times! In fact, from the beginning of regular flight schedules between this country and Europe four years ago, the transatlantic service has been maintained almost entirely by airplanes designed and built by Boeing. These transoceanic Clippers have flown more than 7,000,000 miles, and have carried more than 44,000 passengers and 100,000,000 pieces of mail.

Today these huge ships, designed as peacetime luxury liners, are completing vital missions of war . . . shuttling across the oceans of the world with the monotonous regularity of *ferry boats!*

Behind their dependability of performance stand research, design, engineering and manufacturing skills of high degree, the same skills which have given America the Boeing Stratoliner,* the Boeing Flying Fortress,* and the Boeing Kaydet Primary Trainer.

Tomorrow as well as today you can look for integrity in any Boeing product . . . if it's "Built by Boeing" it's bound to be good.

DESIGNERS OF THE FLYING FORTRESS • THE STRATOLINER • PAN AMERICAN CLIPPERS **BOEING**

*THE TERMS "FLYING FORTRESS" AND "STRATOLINER" ARE REGISTERED BOEING TRADE-MARKS

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Products & Practices

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PRODUCTION

Abrasives 1

Production shortcuts in de-burring, finishing, and polishing are listed in catalog prepared by Weldon Roberts Rubber Co., Newark, N. J. Also given are tables of machine speeds for use of firm's rubber-cushioned abrasive products and wheels

Magnesium Welding.....2

James F. Lincoln Arc Welding Foundation, Cleveland, is distributing reprints of article, Arc Welding of Magnesium Aircraft Structures, which gives engineering account of helium atmosphere process.

Quenching Oil 3

Charts showing comparative efficiency of its "Super-Quench" are contained in booklet on its new quenching oil prepared by Gulf Oil Corp., Pittsburgh.

Gear Cutting 4

Chuckgrams, facsimile telegrams released by Garrison Machine Works, Dayton, Ohio, tell of spur and bevel chucks suitable for various types of gear grinding operations.

Polishing 5

For instruction of inexperienced operators, J. H. Rhodes Co., Chicago, has prepared handbook on setting up polishing wheels, also care and maintenance of felt bobs and wheels.

Coolant Cooler 6

Frostrode Products, Detroit, announces illustrated technical bulletin No. 75-AC describing cooler for maintaining desired temperatures of coolants and lubricants used in grinding, turning, cutting, and other machine processing work.

Weld Testing 7

Various methods of testing welds are described and illustrated in recent issue of *Oxy-Acetylene Tips*, published by Linde Air Products Co., New York City.

Screw Movie 8

Prints in 16 mm. size of sound motion picture, *Thread Grinding—Fully Automatic*, are being made available by Jones & Lamson Machine Co., Springfield, Vt. Movie uses some animation to portray complicated operations of machines for automatically producing precision threads in large and small lots.

Rivet Chart 9

Cherry Rivet Co., Los Angeles, is distributing 20x30 in., two-color wall chart on blind riveting operations showing proper rivet for materials .030 to .391 in. thick, flush riveting operations, proper sizes for brazier head riveting in various thicknesses, and correct riveting technique.

Treating Atmospheres 10

Westinghouse Electric & Mfg. Co., East Pittsburgh, announces new booklet giving chemical reactions, composition, cost, engineering information, and application on equipment employing the heat-treating atmospheres edogas, exogas, monogas, and ammogas in brazing, hardening, tempering, annealing, gas carburizing, sintering, and normalizing.

Metal Gage Comparator.....11

Chart compiled and partially reproduced in folder by R. R. Bostic, Los Angeles, shows gage information for all types of metals and wire for comparing gages direct to decimals, fractions, and millimeters. Chart size is 10½x23 in.

Felt Information 12

Engineering and mechanical applications of felt as a substitute for rubber, cork, and some fabrics and plactics are pointed out in *Felt Facts* by The Felt Assn., New York City., which also shows product's use in reducing vibration and in grinding, filtering, polishing, and other production operations.

MACHINERY & ACCESSORIES

Ball Bearings 13

Catalog No. 110 gives dimensions, loading ratings, and engineering drawings of various types of ball bearings made by Nice Ball Bearing Co., Philadelphia.

Chip Ringer 14

Average yield of about .02 gal. of oil per pound of chips is reported recovered by chip ringer marketed by Fletcher Works, Philadelphia. Its use is pictured in folder which also gives specifications for models with bowls of 14, 20, 26, 40, and 48 in. dia.

Balancing 15

Bulletin No. 26 from Tinius Olsen Testing Machine Co., Philadelphia, describes operation, construction, specifications, and engineering details of horizontal and vertical static and dynamic testing machines for balancing propeller shafts, fluid couplings, supercharger impellers, etc.

Turret Lathes 16

Design, mechanical features, and specifications of its line of Type H heavy duty turret lathes are presented in catalog of Libby Div. International Machine Tool Corp., Indianapolis.

Conveyors 17

Illustrations in folder distributed by Lamson Corp., Syracuse, N. Y., show various installations of overhead conveyor systems for augmenting production.

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31 32 33 34 35 36 37 38 39 40 41

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73 74 75 76 77 78 79 80 81

NAME..... TITLE.....

FIRM OR AFFILIATION.....

ADDRESS.....

Paint Spraying 18

Made for hanging on shop walls, chart gives workers 21 rules on using paint spraying apparatus efficiently. It is released by Eclipse Air Brush Co., Newark, N. J.

Extractor 19

Pictures and text in folder show operation and features of pipe and stud extractor manufactured by Reps Tool Co., New York City, for pipe from $\frac{1}{8}$ to 2 in. and bolts and screws from $\frac{3}{8}$ to $3\frac{1}{2}$ in.

Metal Cutter 20

Illustrated in folder from De Wald Products Corp., Lancaster, Pa., cutting machine for light weight metal can use either circular saw or abrasive wheel, has capacity in ferrous and non-ferrous bar stock to $1\frac{1}{2}$ in., in light walled steel tubing to 4 in., and in flat bar stock to 1x4 in.

Bearings 21

Facts About Anti-Friction Bearings offers 76 diagrams, 41 phantom drawings, photographs, and text to explain functions of various types of bearings, transmission of loads, and designs. Prepared by Ahlberg Bearing Co., Chicago.

Sealer 22

Package Machinery Co., Springfield, Mass., is distributing broadside describing machine for sealing moisture-proof bags of 30 in. max. width and any length. It can be installed for use with conveyor systems.

Pipe Gage 23

Inside diameter of pipe from $\frac{1}{8}$ to 12 in. and proper drill size for tapping are said to be obtainable through use of new pipe gage which Three-Point Gage Co., Chicago, illustrates in folder.

Oil Purifiers 24

Eleven types of oil reclaimers in its A and GH series with capacities of $2\frac{1}{2}$ to 120 gal. in 70 to 90 min. are illustrated with specifications in folder by Youngstown-Miller Co., Sandusky, Ohio.

Hydraulic Catalog 25

Information for engineers in new catalog on hydraulic cylinders produced by Hanna Engineering Works, Chicago, includes schematic drawings and dimensions, mounting arrangements, velocity and piston alignment charts, cushioning, and hand- and foot-operated valves.

Finishing Machines 26

Bulletin No. 502 of Hammond Machinery Builders, Kalamazoo, Mich., gives information regarding the company's machines for grinding, polishing, and buffing tubes, bars, rods, and other cylindrical shapes from $\frac{1}{4}$ to 9 in. o.d.

Flaring Tool 27

Following introduction of soft steel, copper-coated tubing as a substitute for copper and aluminum, Everhot Products Co., Chicago, announces special flaring tool for use on this substitute tubing. It is designed for sizes from $\frac{1}{8}$ to $\frac{3}{8}$ in. o.d. and it is shown in catalog sheet issued by the company.

Screws and Lacing..... 28

The Bristol Co., Waterbury, Conn., announces Bulletin No. 773 on its line of steel belt lacing and Bulletins Nos. 849 and 850 giving respective prices on its multiple-spline and hex type screws.

Tool Steel 29

Tungsten-molybdenum steel made under name "Mustang" by Jessop Steel Co., Washington, Pa., is said by company to deliver maximum hardness and wear resistance for tools operating at more than 300 deg. F. Applications, analysis, and information on forging, annealing, hardening, quenching, and tempering, properties and forms available are given in illustrated leaflet.

Belt Surfacing 30

Booklet prepared by Porter-Cable Machine Co., Syracuse, N. Y., explains the company's apparatus for wet belt machining of hard and soft metals, other compositions, as well as rubber, plastics, and wood.

PLASTICS

Phenolic Data 31

Information for engineers and industrial designers on the properties, manufacture, and uses of Dilecto, laminated phenolic plastic produced by Continental-Diamond Fibre Co., Newark, Del., is given in charts text, and photos in Company's Catalog No. DO 43.

Plexiglas Data 32

Booklet prepared by Rohm & Haas, Philadelphia, contains technical data on the mechanical properties of plexiglas. Specific gravity, hardness, strength, modulus of elasticity, and cold flow or creep are considered in illustrations, tables, charts, and text.

• Announcements of new machine tools and shop equipment and accessories are invited for inclusion in these columns. In writing, emphasis upon aviation industry applications of newly-marketed items is desirable, and, wherever possible, glossy-print photos should be enclosed for illustration. Manufacturers should address New Products Editor, AVIATION, 330 W. 42nd St., New York City.

Lucite 33

Vol. 5 of *Plastics Bulletin* prepared by E. I. du Pont de Nemours, Arlington, N. J., contains physical property data, illustrations, and graphic and textual descriptions of new heat-resistant "Lucite" methyl methacrylate resin molding powder.

ELECTRICAL

Fitting Charts 34

Two wall charts prepared by Cannon Electric Development Co., Los Angeles, on AN connectors show scale-size insert arrangements and part identification numbers.

Electronic Equipment 35

Electronic Enterprises, Newark, N. J., publishes booklet of operating principles, construction, and specifications of its various electronic equipment, including mercury vapor rectifier tubes, half-wave mercury vapor and half-wave high-vacuum rectifiers, oscillator, and transmitting triode.

Insulators 36

Technical data on the installation of its vibration insulators in conjunction with aircraft radios is contained in Bulletin No. V-1 offered by Harris Products Co., Cleveland.

Power Plants 37

On experience of 300 power plants, Oakite Products, New York, has listed in booklet 65 cleaning and servicing procedures for lengthening life of steam generating, and electric power and light plants. Company also issues booklet describing its Composition No. 90 for Anodic degreasing of steel and copper.

Light Flasher 38

Wallace & Tiernan Products, Belleville, N. J., issues folder explaining construction of its device, approved by CAA, for flashing aircraft tail lights. It employs a motor connected to a d.c. circuit.

MANAGEMENT & EMPLOYEES

Foremanship Film 39

Sound movie of foreman's duties at Pratt & Whitney Aircraft, East Hartford, Conn., shows importance of maintaining good relations within and without the foreman's department. Picture, available to other manufacturers on a service basis, runs 41 min.

Office Records 40

Recent issue of *Systems*, published by Remington Rand, Buffalo, shows how company's systems for keeping records of production, materials, parts, etc., have been employed in aircraft and other manufacturing plants.

Termination Regulations 41

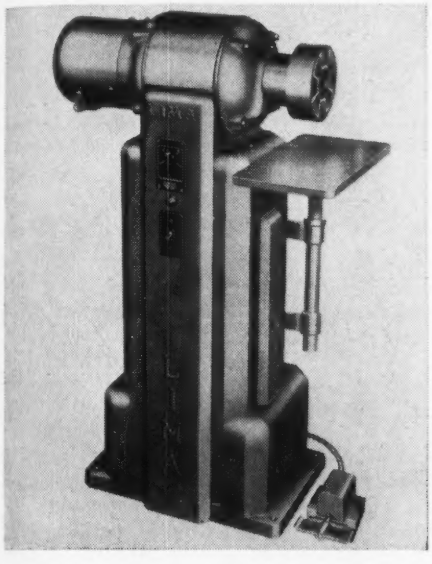
Aeronautical Chamber of Commerce, Washington, is distributing, at printing cost, copies of War Dept. regulation, *Termination of Contracts for the Convenience of the Government.*

Latest Machine Tools

NEW PRODUCTS

Magnetic Polisher.... 42

Direct current supplied by a rectifier is used to hold parts from 1½ in. dia. and up in polishing lathe announced by **Lima Electric Motor Co.**, Lima, Ohio. Available in pedestal or bench types with various motor speeds to 3,600 rpm., polisher is controlled by a foot pedal



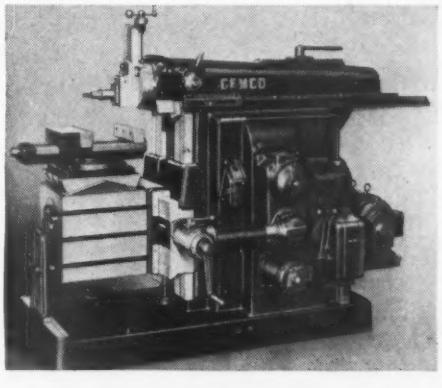
which magnetizes chuck and starts and stops motor at the same time. Swinging table attached to pedestal can be adjusted to various size chucks.—AVIATION, *Nov.*, '43.

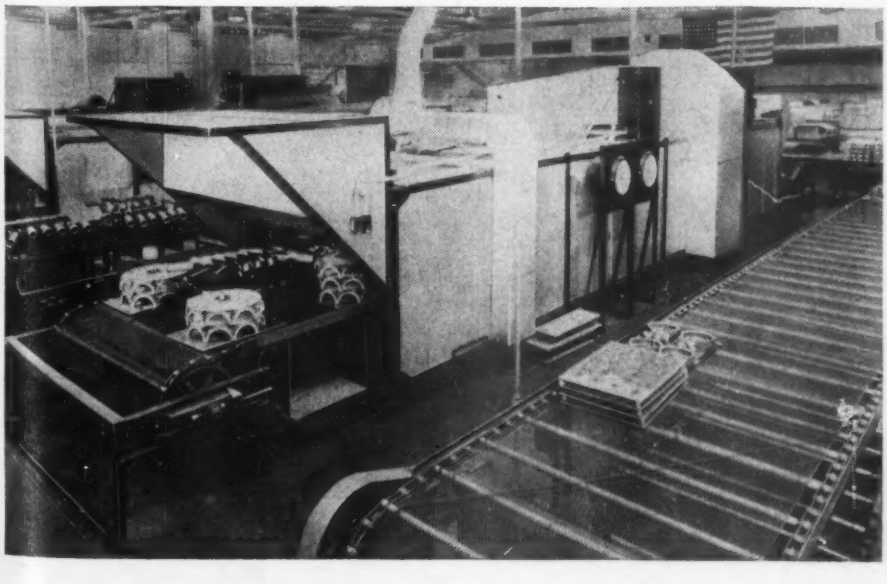
Paint Baker 43

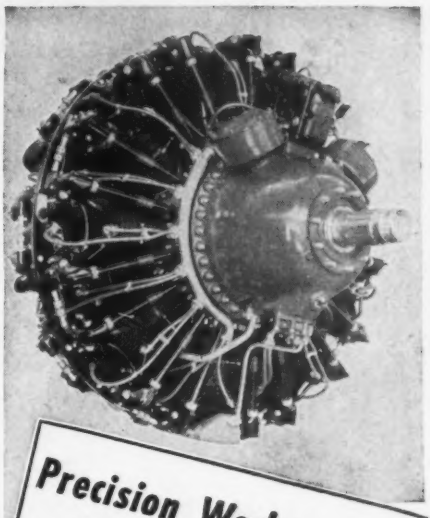
Designed for aircraft engine plants, paint baking oven for various size aluminum alloy parts has a continuous flat screen conveyor 40x5 ft. It is supported on cross pieces in a heavy chain which is driven by variable speed drive. Air to volatilize paint solvents is supplied to a fuming zone at 150 to 225 deg. F. Baking heat of 350 deg. F. is created electrically; air circulates over the heaters, through the working section of the oven, and finally back to a recirculating fan in the oven roof. Automatic controls maintain temperature, and safety switches shut off heat and motor if fan or power supply fails. Baseplates which carry parts through oven are returned to loading end on a conveyor, reports maker, **The Gehnrich Corp.**, Long Island City, N. Y.—AVIATION, *Nov.*, '43.

Shaper..... 44

Three types of shapers offered by **General Engineering & Mfg. Co.**, St.







Precision Workmanship in a Great Engine

AMERICAN built planes are bringing the Axis nearer and nearer to the day of reckoning. Airplane engines like this are at the core of the drive. These great engines — power-houses of tremendous energy packed in a surprisingly small space — require the finest built parts fitted to close tolerances to perform their exacting tasks.

Many parts for planes and aircraft motors are produced in the Fenn plant, where skill and craftsmanship are devoted solely to war production tasks.

A capable engineering staff, directed by alert management, stands ready to help manufacturers with their production problems.

Fenn acts as prime contractor or sub-contractor on Special Machinery, parts and equipment. We welcome inquiries from those who need assistance in either development work or actual production.

FENN

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HARTFORD, CONN.

ESTABLISHED 1900

-The Search ends with "ALLENS"

In tests of arms, explosive shocks make war on hollow screws. Giant stresses attack the holding-power of fastenings. Behind battle-fronts the machinery of production strains and batters away at restraining *threads.*

But for 30 years before this war, "ALLENS" met tests no less critical at the time. Each new demand for holding-power brought new Allen developments *in advance.* We proffer you now—Dependability *IN ADVANCE.*

★ ★ ★

Order through your Industrial Distributor, to take advantage of his position as the *mass-purchasing agency* for your locality.

THE ALLEN MANUFACTURING COMPANY
HARTFORD, ★ ALLEN ★ CONNECTICUT, U.S.A.

NEW PRODUCTS

Louis, have range of 11-140 and 10-130 strokes per min. Sizes available are 16-20 and 16-20-24 in. with standard equipment including single or double screw vise, operating wrenches, and V-belt or motor drive. Accessories available are powered rapid transverse, powered down feed, concave attachment, mold maker's vise, and tilting-top table. Special features of machine are said to be lubricating system which prevents main control from being operated if oil pressure is low or if main motor drive is stopped, lock which prevents tool head from creeping under heavy cuts, and adjusting dials raduated in thousands.—AVIATION, *Nov.*, '43.

Oil Purifier 45

Line of engine oil purifiers manufactured by **The Hilliard Corp.**, Elmira, N. Y., is now announced to include models for handling from 50-65 gal. per hr. to 75-130 gal. and more. Cleaning operation involves use of "Hilite" fullers earth or activated clay, which absorbs foreign solids after the mixture has been heated to dispell moisture and dilution. Compressed air then forces mixture through a filter press, which retains solids, and finally through a secondary filter.—AVIATION, *Nov.*, '43.

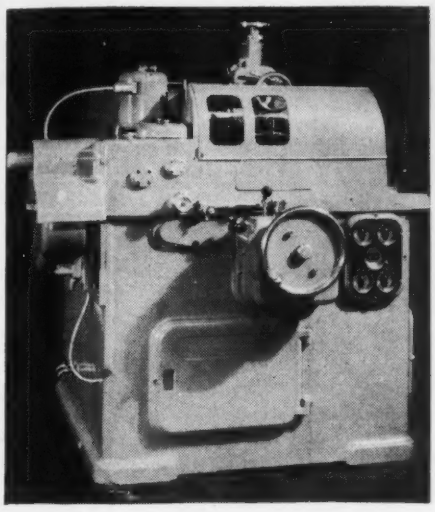
Plywood Planer 46

For planing of ply and other woods in lengths as short as 6½ in., machine made by **Boice-Crane Co.**, Toledo, has two idler rolls on adjustable journals for steady feeding which can be stopped without cutting off power. Bench and

floor models are offered with V-belt drive from electric motor or from lineshaft or gasoline engine.—AVIATION, *Nov.*, '43.

Thread Grinder..... 47

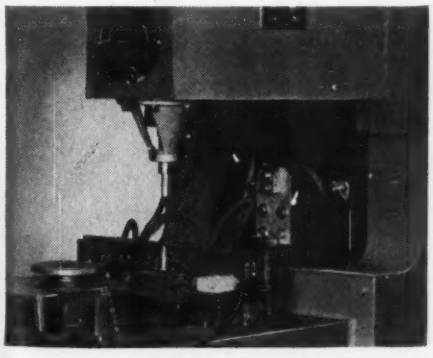
American-designed thread grinder for single- or multi-ribbed wheels is announced. It will take work up to 12 in. long and grind 8 in. of it in single or multiple right- or lefthand threads



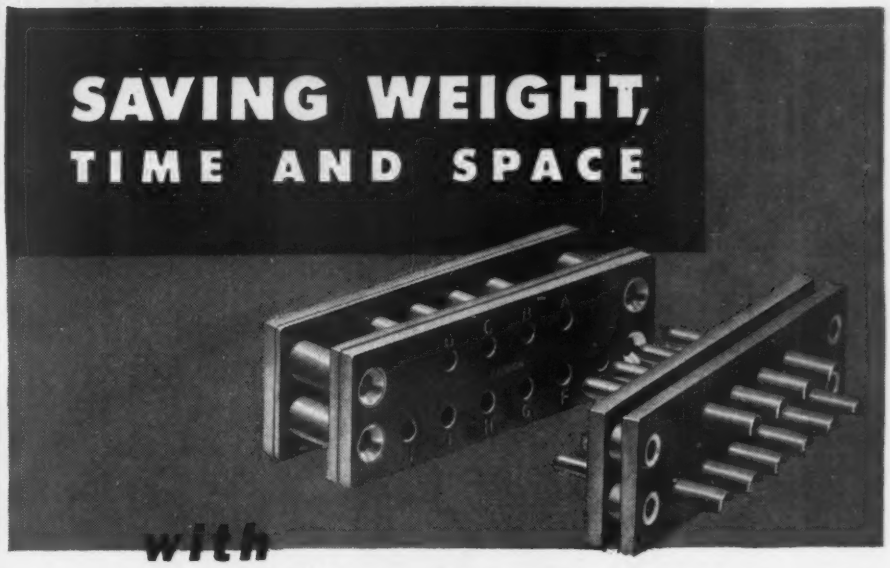
in any pitch up to 60 per in. Maximum work diameter is 7 in. and maximum thread diameter 3 in. Two, three or four threads, reports **The Sheffield Corp.**, Dayton, Ohio, can be made in one pass. Some models are offered for automatic cycle grinding; with them the operator, after initial set up for first piece, need only load and unload machine, and move lever which repeats cutting cycle.—AVIATION, *Nov.*, '43.

Riveting Welder..... 48

Machine designed by **Progressive Welder Co.**, Detroit, for resistance weld-



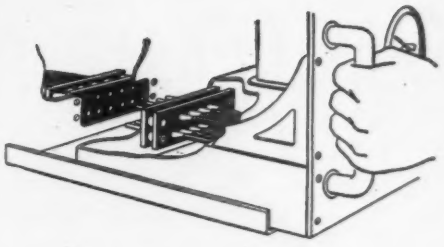
ing has been adapted to rivet stamped assemblies. In one instance (illustrated) welder, equipped with indexing table, hot-upsets and rivets hydraulic flywheel vanes. Conventional welding timers, operating on lower current density, supply proper amount of heat to ends of vanes which protrude through an assembly ring.—AVIATION, *Nov.*, '43.



with

CANNON PLUGS

This panel connector is one of the Cannon DP series. It was developed primarily for use on radio and instrument plug-in equipment where weight, space and convenience of operation are often prime considerations



Both halves of this connector are mounted rigidly. One half mounts on the back of any electrically operated unit. The other half mounts on a rack or panel designed to hold the unit. By this means the excess weight of terminal strips and slack in the cable are eliminated.

In addition to saving weight, Cannon DP Connectors offer many convenient and time-saving advantages in servicing operations.

24 page bulletin with drawings and engineering data on DP connectors available on request. Address Department A-110, Cannon Electric Development Co., Los Angeles 31, California.

CANNON ELECTRIC

CANNON ELECTRIC

Cannon Electric Development Company, Los Angeles 31, Calif.

Canadian Factory and Engineering Office: Cannon Electric Co., Limited, Toronto

REPRESENTATIVES IN PRINCIPAL CITIES—CONSULT YOUR LOCAL TELEPHONE BOOK

THEY ALL GET TOGETHER ON THIS

American flyers in the Far East favor one type of fighter plane — the Russians pick another type — the British go for a third — and still a fourth is the special pet of scrappy American birdmen rolling up records around southern Europe and in the Aleutians. ★ All four of these American-built fighters have one thing in common—the Allison engine. ★ And typical of the high regard in which the flyers hold this engine is that of one much-decorated American pilot, who says bluntly, "No engine is more dependable than the Allison." ★ We're glad they feel that way. That is welcome reward for the pains Allison takes — in design, in materials, in workmanship—to achieve peak precision and superfine quality. ★ It is General Motors' purpose to build the best aircraft engine in the world. ★ How well we succeed is a matter best reflected by actual combat results.

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P-38—Lightning
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LIQUID-COOLED AIRCRAFT ENGINES

Allison

DIVISION OF GM GENERAL MOTORS

Shop Equipment and Accessories

Tire Bead Loosener 49

Said to be suitable for loosening rims from beads of tires from small tail-wheel type to 65 in. size, new tool developed by **Firestone Tire & Rubber Co.**, Akron, comes in kits 38x6x6½ in. which weigh 48 lb. It is reported to make

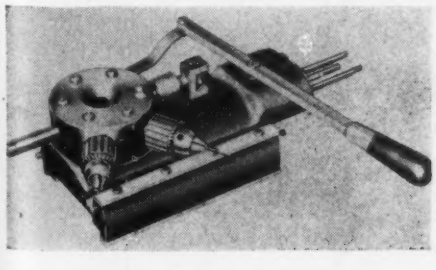
woman's work out of a difficult job. In removing a tire, hooks are forced between rim and bead by a lever and two tire irons are used (photo) to loosen bead. Loosening tire from rim, Firestone says, is still a two-man job with equipment supplied with kit, which also contains tools for valve work and a hammer for one-man tire mounting.—AVIATION, *Nov.*, '43.

Standard Cutters 50

Line of standardized thread milling cutters, cut from blanks by number and thread specification by **Detroit Tap & Tool Co.**, Detroit, include 40 different shell types from 1½ to 3½ in dia. and 12 shank types from ¾ to 1½ in. dia. Both have right-hand spiral flutes and 5 deg. rake angle.—AVIATION, *Nov.*, '43.

Lathe Turret..... 51

Self-indexing lathe-bed turret with six tool stations and individual stops introduced by **Kessler Aero Tool Co.**, Burbank, Calif., can be back-indexed by hand when less than full set of six tools are used. Operating lever has maximum stroke of 4 in.; minimum index stroke is 1½ in. Pre-loaded Timken bearing, adjustable for wear, supports turret head.—AVIATION, *Nov.*, '43.



Protective Film 52

Applied by brushing or dipping, protective coating made by **Insl-X Co.**, Brooklyn, can be stripped from rough or smooth parts by hand. No further cleaning is required. Coating is reported to dry quickly after application and to have withstood 100-hr., 3-percent salt spray tests on steel, copper, brass, and aluminum. It is manufactured in types for long- and short-term service.—AVIATION, *Nov.*, '43.

AN-S-14
AN-QQ-S-684
AN-QQ-S-752

Aircraft Alloy Steels in Ryerson Stocks

Aircraft quality 8630, X4130 and 4140 alloy steel bars—hot rolled, cold finished and heat treated—in a wide range of sizes are carried in stock for immediate shipment from Ryerson plants at Chicago, St. Louis, Cincinnati and Jersey City. These steels conform to specifications: AN-S-14, AN-QQ-S-684, and AN-QQ-S-752 respectively and are readily available to aircraft manufacturers and their subcontractors under the ACW program. A special booklet of stocks on hand, "Aircraft Alloy Steels," including condensed specifications for AMS and AN-S steels, will be sent to you on request.

Other steels at ten Ryerson plants comprise over 10,000 different kinds, shapes and sizes—everything in steel. Call your nearby Ryerson plant first—for quick action on steel.

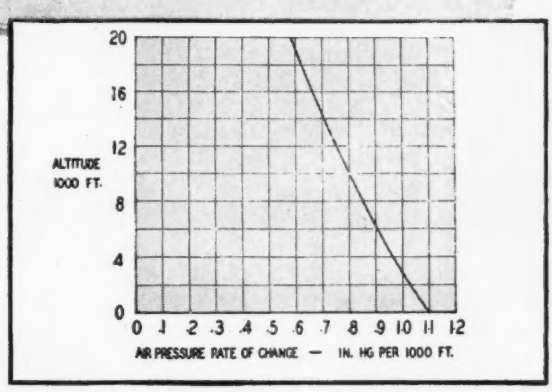
Joseph T. Ryerson & Son, Inc., Steel-Service Plants at: Chicago, Milwaukee, St. Louis, Detroit, Cleveland, Cincinnati, Buffalo, Boston, Philadelphia, Jersey City.

RYERSON

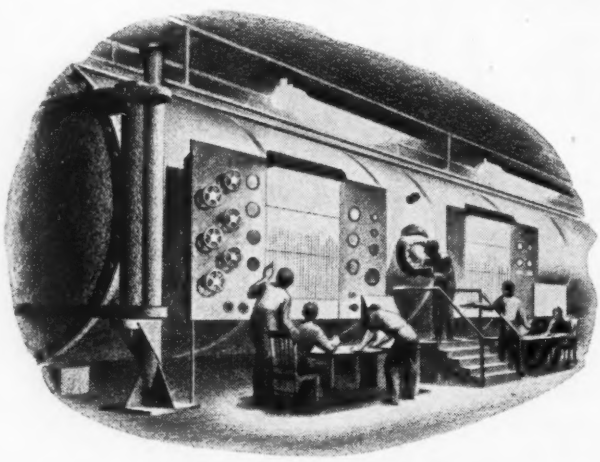
Three reasons to PRESSURIZE CABINS FOR LOW-ALTITUDE FLYING!

5. What do you dislike about flying ?

Can't stand the "ups and downs"
I always feel dizzy
Makes my ears ache



A RECENT SURVEY reveals the most common passenger objections to air travel are the *discomforts caused by changing air pressures.* And as chart here shows, pressure changes are most severe at the comparatively low altitudes through which most airlines operate . . . and are greatest during the airliner's climb and descent.



IN OUR "STRATOLAB," AiResearch engineers have been perfecting controls to *hold pressure constant* during climbs and descents . . . to *adjust pressure* gradually during airliner flight from low to higher altitude airports.

AiResearch Cabin Pressure Regulating Systems will be able to hold *sea level* altitude inside airliners flying as high as 20,000 feet!

From this AiResearch engineering will come pressurized cabins for postwar airliners—"living room" comfort for passengers at all times . . . and increased travel business for the airlines.

Information is available now to U. S. aircraft manufacturers and airline operators.

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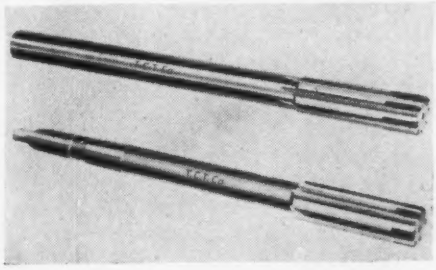
"Where Controlled Air Does the Job" • Automatic Exit Flap Control Systems • Engine Oil Cooling Systems • Engine Air Intercooling Systems • Exhaust Heat Exchangers • Supercharger Aftercooling Systems • Engine Coolant Systems

Carbide Reamers..... 53

Hardened shanks are being offered by **Tungsten Carbide Tool Co.**, Detroit, in its line of standard-sized carbide tipped reamers. With straight or tapered shanks, they are available in sizes from



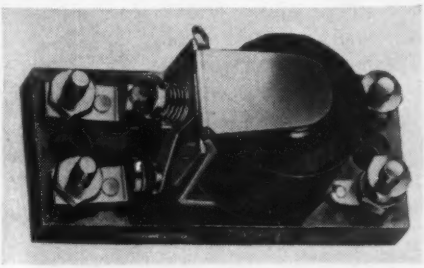
$\frac{1}{4}$ to $1\frac{1}{2}$ in. Up to 1 in., steps are $\frac{1}{32}$ in. apart; above that diameters change in 16ths. There are four flutes on sizes up to $\frac{1}{2}$ in., six flutes to $\frac{13}{16}$ in., and eight on larger sizes. Tips are diamond-ground and outside diameter said held to tolerance of +0 and −0.0003 in.—AVIATION, *Nov.*, '43.

Plugs and Sockets..... 54

With 2, 4, 6, 8, 10, and 12 contacts, plug and socket series 2400 of **Howard B. Jones**, Chicago, features increased leakage path and interchangeability with firm's 400 series. Bakelite molded according to Navy specification 17P4, plugs and sockets have contacts recessed in pockets. Barriers surround new type contacts which have four flexing surfaces for each plug prong. Socket contacts are silver-plated phosphor bronze while plug contacts are silver-plated brass ¼x1/16 in. Shallow brackets are available for flush mounting, deep brackets for recessed mounting.—AVIATION, *Nov.*, '43.

Contactor..... 55

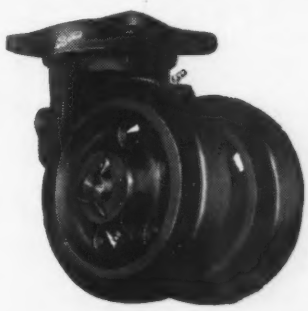
To meet AAF specification 94-32185D, **Square D Co.**, Industrial Controller Div., Milwaukee, has developed contactor for remote control, regulation of d.c. motors,



THESE Bond Aviation Casters are the newest application of the time-tested Bond policy of building casters to fit the job. They're specially engineered for aircraft production—and aircraft production is just what they're promoting in leading plants. Put 'em on *your* job . . . and materials will move faster.

BOND V-GROOVED WHEEL CASTER

Built especially for use on track line assembly—which eliminates obstructions to materials flow—this new Bond Caster saves time and floor space . . . reduces effects of floor vibration. Double ball race construction. Pressure lubricated throughout.



Get the Facts FREE!

New Bond Folder R-39 gives you the facts about all of the Bond Aviation Casters. Write for your copy today.

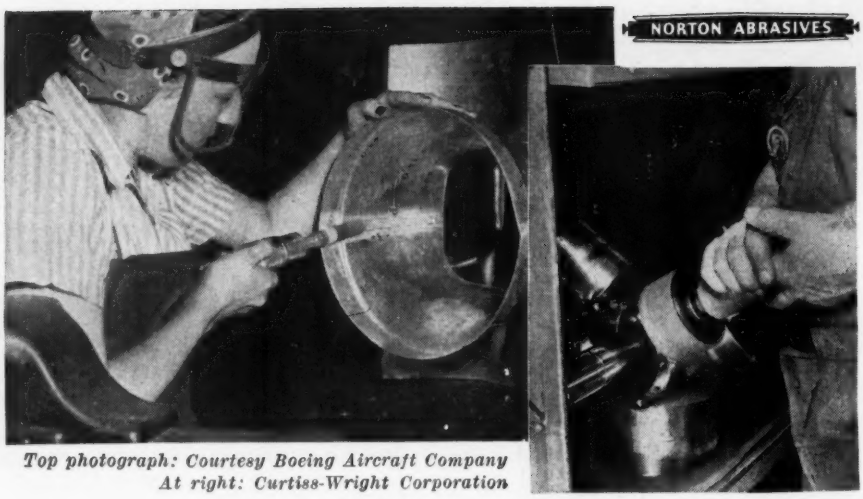
BOND DUAL WHEEL CASTER WITH OSCILLATING AXLE

This Bond Caster levels out the bumps because both wheels always hug the floor no matter how rough the surface. Oscillating axle distributes the load evenly on both wheels. Sudden tilting of engine stands is eliminated . . . shock is reduced . . . damage prevented. Double ball race construction. Pressure lubricated throughout. Also supplied with Swivel Lock.

BOND FOUNDRY & MACHINE COMPANY, MANHEIM, PA.

Bond TRUCK CASTERS

* Reg., U. S. Pat. Off.



Top photograph: Courtesy Boeing Aircraft Company
At right: Curtiss-Wright Corporation

Saving TIME, MONEY— *Possibly* LIVES

YOU'LL BE ASTONISHED at the speed and economy with which these Metalite Cloth "Gadgets" do slow, costly little metal finishing jobs. The accuracy of finish or radius produced by them on many vital parts also contributes to the eventual performance and safety of the whole.

Honestly, now, have you fully explored what these many little abrasive cloth forms can do for you right on tools now in use in your plant? Have you had a Behr-Manning Field Engineer show you all the shapes and sizes—even demonstrate them on the jobs you select?

Concerns such as those who supplied our illustrations have made great savings by adopting "Gadgets" as the principal means of doing the most irritating kind of finishing operations—irritating because the time consumed formerly was so out of proportion to their size.

Write direct to Troy or our nearest Branch for the services of one of our able Field Engineers.

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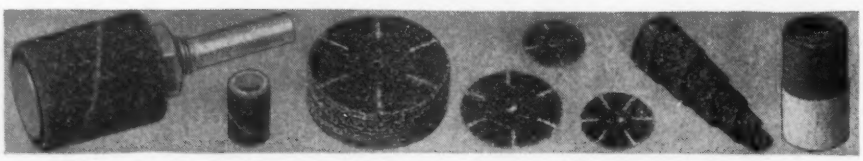
(DIVISION OF NORTON COMPANY)

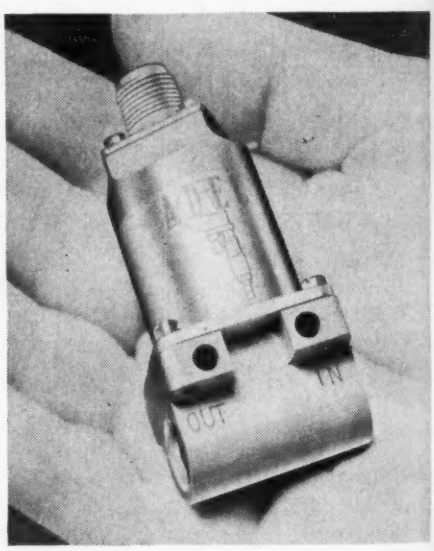


NEW PRODUCTS

and relaying in gunfiring, lighting, and communication circuits. Known as Type B2A, contactor is rated at 25 amp. continuous duty up to 29 v. d.c. and is reported to operate up to 10G and vibrations of 55 cycles per second at $\frac{1}{8}$ in. excursion. No damage is said to result from exposure to temperature extremes of —75 to 200 deg. F.—AVIATION, *Nov.*, '43.

Fluid Valve..... 56

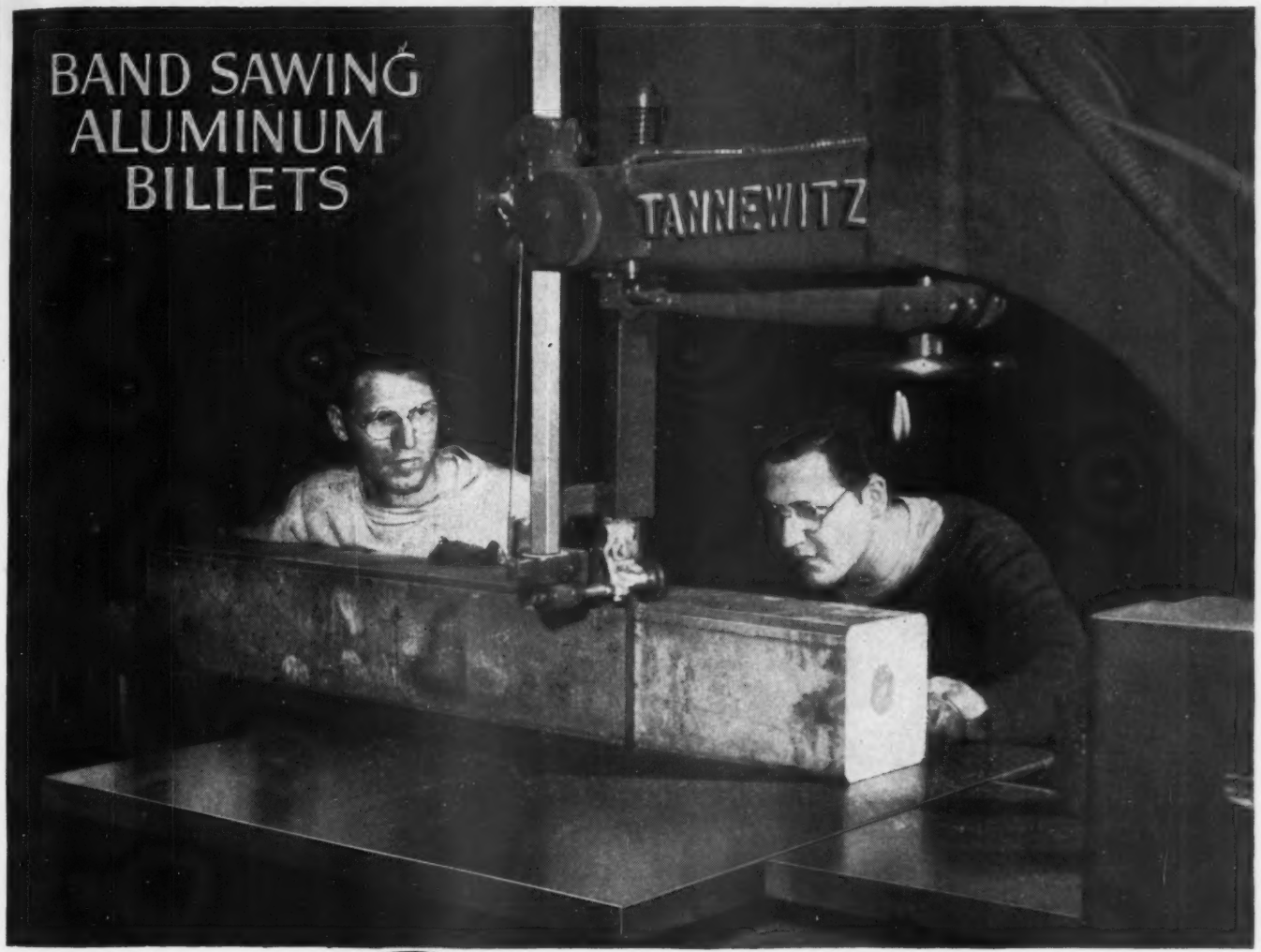
A new solenoid operated fluid shut-off valve which weighs 6.96 oz. is announced by **Adel Precision Products**, Burbank, Calif. It was designed for remote control of anti-icing fluid flow and is also adaptable for control of heater fuel, oil dilution, and lavatory and drinking water



in commercial transports. New valve has a dural body, is equipped with standard AN 3102-8S-1P receptacle, and comes in port sizes for $\frac{1}{8}$ in. pipe thread or $\frac{1}{4}$ in. tube fittings. Valve is normally closed and installation may be planned for any operating position. Current requirement is .25 amp. at 24 v. dc., and units are available for working pressures of 50 and 250 psi. They have been approved by Society of Aeronautical Weight Engineers.—AVIATION, *Nov.*, '43.

Tubing Protector..... 57

Developed by **Packless Metal Products Corp.**, New Rochelle, N. Y., at request of aircraft manufacturers, hose strap to eliminate whip consists of cone-spiral spring which is screwed to supporting surface and snaps over hose or tubing.—AVIATION, *Oct.*, '43.



Tannewitz
METAL CUTTING BAND SAWS

. . . are constantly effecting truly amazing production increases, with corresponding reduction of costs, in the cutting of:

•

SHEET STEEL and NONFERROUS METALS — BOTH FORMED AND FLAT

•

CUTTING OFF GATES AND RISERS FROM CASTINGS OF ALL SIZES AND TYPES OF METAL

•

CUTTING LARGE BLOCKS OF ALUMINUM, MAGNESIUM and OTHER METALS

•

DI-SAWING — INSIDE AND OUTSIDE FILING and POLISHING

•

The complete line affords machines to accommodate work of any size. Take the first step towards eliminating the bottle neck of metal cutting by writing for bulletins listed at left.

BULLETINS

Worth Writing for:

SHEET METAL CUTTING BAND SAWS

•

SINGLE AND VARIABLE SPEED BAND SAWS FOR FOUNDRY USE

•

BAND SAWS FOR DI-SAWING, FILING and POLISHING

THE TANNEWITZ WORKS, GRAND RAPIDS, MICH.

NEW PRODUCTS

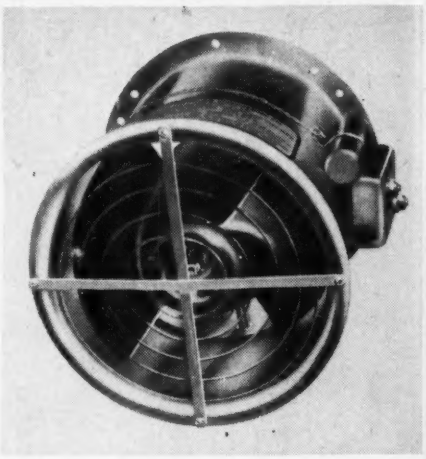
parts. They have malleable motor housings and throttle heads. Models are manufactured with button or lever throttle controlling speeds of 15,000 to 18,000 rpm. Maker, **Aro Equipment Corp.**, Bryan, Ohio, gives weight as 4 lb. Adapters, collets, and extensions can be supplied.—AVIATION, *Nov.*, '43.

Portable Grinders..... 58

For grinding and cleaning foundry castings, portable pneumatic grinders will take 2 in. wheel or rotary file burrs for working on aluminum or magnesium

Cabin Fans..... 59

Light weight, high pressure axial flow fans in three sizes are announced by **Dynamic Air Engineering Co.**, Los Angeles, for recirculation of cabin air



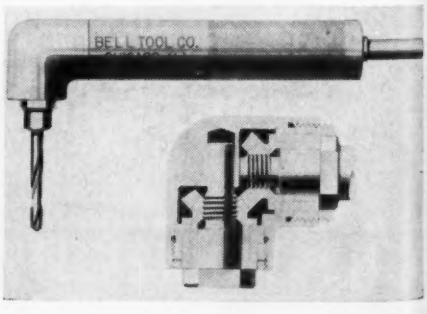
through gasoline combustion heaters on medium and heavy bombers. Smallest of three, powered with a $\frac{1}{3}$ hp. series wound, 24-28 v. motor, weighs 5.7 lb. and delivers 320 cfm. air at sea level against 2 in. water gage pressure, or 450 cfm. against $1\frac{1}{2}$ in. at 20,000 ft. Inside diameter is 6 in. A second size (illustrated) with $\frac{1}{2}$ hp. motor and a second propeller on a double-extended shaft, delivers 25 percent more volume at double original pressure. Third unit is 7 in. dia. and will deliver approximately 60 cfm. at 5 in. pressure.—AVIATION, *Nov.*, '43.

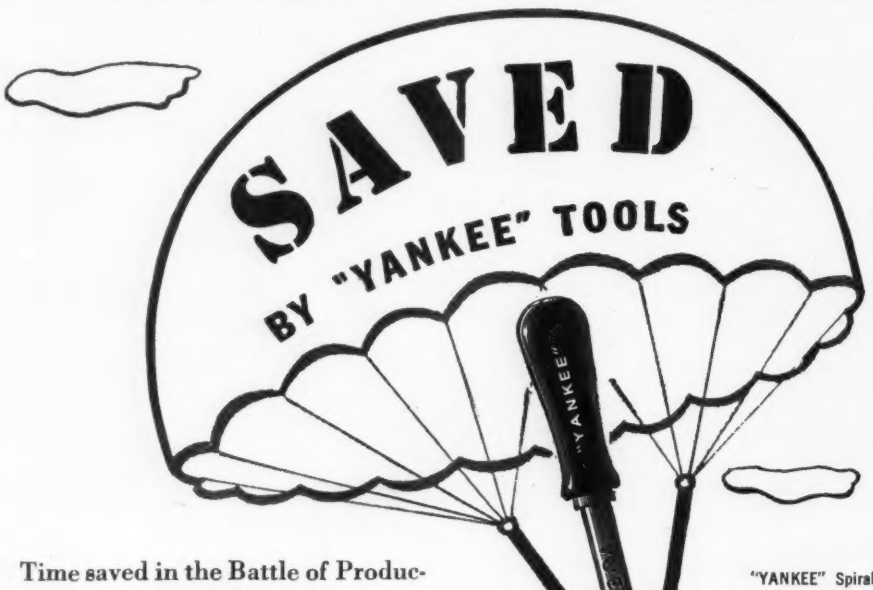
Plastic Insulation..... 60

Furnished by **Carter Products Corp.**, Cleveland, plastic tubing for electrical insulating work contains color stripes for identification. It is known as "Striatube" and is available in flexible or rigid form of various sizes, thicknesses, and lengths. Company states it has high dielectric strength, non-oxydizing properties, and good resistance to acids, alkalies, oils, and greases.—AVIATION, *Nov.*, '43.

Angle Tool..... 61

For use on flexible shafts and small portable tools in drilling, reaming, burring, countersinking, and light grinding, new 90 deg. angle head employs miter gears operating in large ball bearing surface. **Bell Tool Co.**, Chicago, gives dimensions as $1\frac{5}{32}$ in. high and $5\frac{7}{16}$ in. long including power-receiving shaft.—AVIATION, *Nov.*, '43.





"YANKEE" Spiral Screw Driver No. 130A

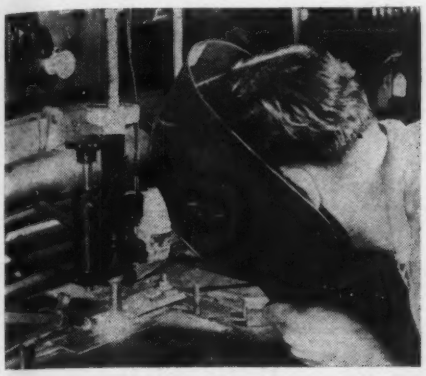
Time saved in the Battle of Production shortens the days to Victory . . . and "Yankee" Fine Mechanics' Tools save time. A minute here and a half-minute there seem unimportant in themselves. Multiplied by the thousands of "Yankee" Tools in service, they total hundreds of man-hours. . . . For nearly half a century, "Yankee" on tools has been the mark of ingenious and dependable performance — of faster and easier work on countless jobs. Safeguard your "Yankee" Tools. They are weapons of war and must be treated right. And when they again become the tools of peace, you will find them immediately useful for your post-war needs.

Order from your supply house, or write North Bros. Mfg. Co., Dept. AV-1143, Phila., Pa. Furnish priority ratings whenever possible, and every effort will be made to fill your orders.

"YANKEE" TOOLS
make good mechanics better
North Bros. Mfg. Co., Phila. 33, U. S. A.
Established 1880

Helium Welding 62

General Electric Co., Schenectady, N. Y., announces development of manual and automatic equipment for arc welding with helium of magnesium and its alloys, aluminum, and light weight alloys. Automatic unit (illustrated in use



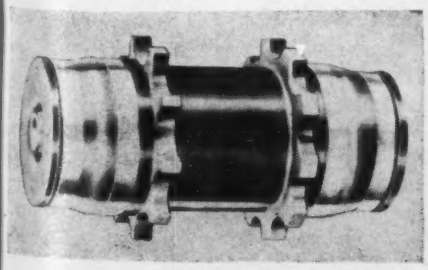
at G-E laboratory) is stated to weld up to 40 in. min. in $\frac{1}{8}$ in. stock. Magnesium filler is here unrolled into work through nozzle rod (lower left). Tungsten electrode extends through rod perpendicular to work. Helium is discharged around this electrode. Electronic motor control maintains even arc length which can also be drawn by a carbon electrode.—AVIATION, *Nov.*, '43.

Screw "Rivet" 63

New fastener consists of recessed-head screw inserted in hollow aluminum alloy stem with a knurled nut on end of screw. Drawing up on screw tightens whole assembly. **Pacific Railway Equipment Co.**, Los Angeles, says it is suitable for any job where rivets, particularly blind ones, are used. After regular riveting procedure of drilling, burring, reaming, gaging, and clamping, screw rivet is installed by power screwdriver fitted with special finder. Two available types, flush and raised head, are made in $\frac{1}{8}$, $\frac{5}{32}$, and $\frac{3}{16}$ in. dia. and normal range of grip lengths.—AVIATION, *Nov.*, '43.

Ammunition Booster 64

Device for feeding .50 caliber ammunition to aircraft guns has motor-driven sprocket which engages linked shells. Device, $5\frac{11}{16}$ in. long and $3\frac{1}{8}$ in. dia., operates on 24 v., drawing 10.5 amp. under 40 lb. load. It will deliver 840 rounds a minute, and life is given as upwards

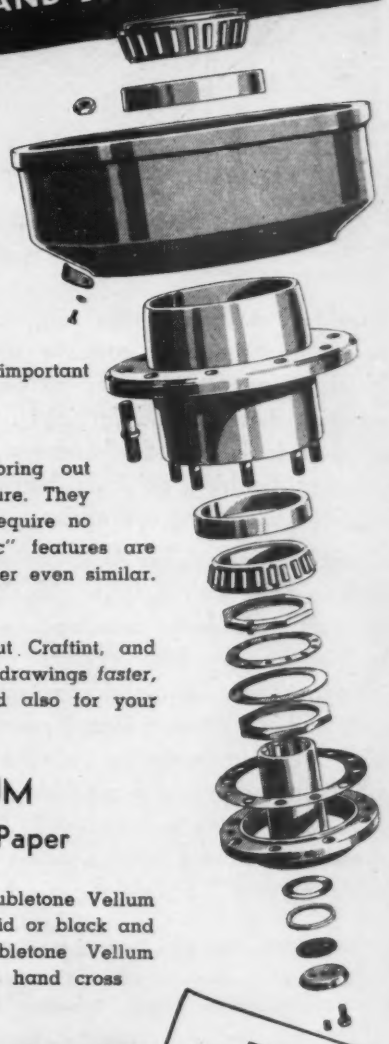


of 50,000 rounds. It is reported to operate up to 40,000 ft. and between temperatures of −70 to 160 deg. F. Maker is **H. L. Harvill Development Co.**, Vernon, Calif.—AVIATION, *Nov.*, '43.

Indicator Tester 65

Device manufactured by **Clark Instrument**, Detroit, employs sine bar principle of checking against tangent of angle in testing dial indicating instruments. When indicator is mounted on top of tester with its zero reading coinciding with that of tester, a screw, which articulates a lapped block in contact with indicator spindle, is turned to check accuracy of readings at other points of indicator dial. Device is also reported suitable for checking direct and reversed reading indicators on Rockwell hardness testers.—AVIATION, *Nov.*, '43.

CRAFTINT SPEEDS PRODUCTION OF HANDBOOKS AND MANUALS



★ Hundreds of Aircraft and Parts Manufacturers have switched to Craftint Doubletone Drawing Paper in order to speed production of their vitally important Hand Books and Manuals. Craftint enables any draftsman or commercial artist to make three-dimensional drawings in a fraction of the time required to do hand shading. The countless man hours that Craftint saves are an important contribution to the war effort.

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Used in machine shops and tool rooms for finishing intricate dies. Used on production lines to clean castings, turnings and forgings . . . sharpen tools and do hundreds of grinding, finishing, polishing, burring, routing and etching operations.

Dremel Moto-Tool has AC-DC motor with shock-proof bakelite housing, oil-sealed (oil-less) bearings, and built-in cooling fan. Weighs only 13 ounces—so light and compact a *girl* can handle it with ease. Dynamically balanced armature eliminates vibration and provides precision control. Moto-Tool's high speed (27,000 rpm) permits finer, faster work—conserves cutters.

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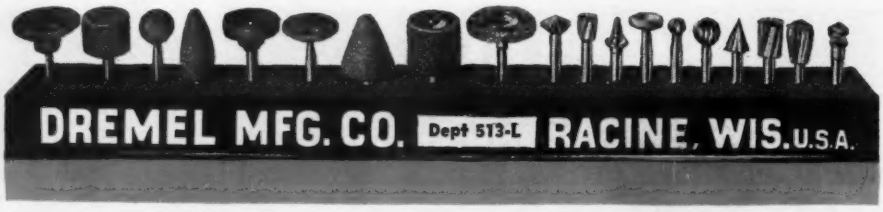
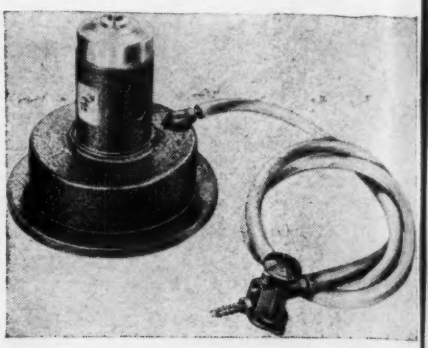
Whether you have a Moto-Tool or any other type of grinder, use only genuine Dremel shop-tested Accessories—steel cutters, grinding points, brushes, sanders, etc. Write for literature.



DREMEL MFG. CO. Dept 513-L **RACINE, WIS. U.S.A.**

Collet Fixture 66

Hollow ram with rod for controlling depth is provided on pneumatic collet fixture which has maximum capacities of 1 in. round, $\frac{33}{32}$ in. square, and $\frac{7}{8}$ in. hexagonal. Adapter is provided for connecting this ram to standard draw-in collet up to 1 in. capacity. Control valve may be operated by foot pressure or attached for automatic operation to machine being used. Gripping power, says maker, **Mead Specialties Co.**, Chicago, is sufficient to hold cylindrical alloy steel while outside threads are cut with self-opening or ordinary dies. Sealing of fixture permits use of lubricants and coolants; alternate housing is available with openings for pumping oil through collet. Second control valve may be installed for operating automatic air ejecting mechanism provided in special base.—AVIATION, *Nov.*, '43.



Sealing Tapes 6,

Furnished in 50-ft. rolls from $\frac{1}{2}$ to 2 in. wide three types of sealing tapes are reported in wide aircraft use by **Pittsburgh Plate Glass Co.**, Pittsburgh. They are (1) Fabseal—impregnated fabric gasket material which can be compressed to .010 in. when used as gasket in flying boat hulls and gas and oil tanks; (2) Chromseal—softer, solid ribbon fabric-less compound that can be hand-molded for gasket use between riveted or bolted sections of integral or droppable fuel tanks and as a seal around plastic and glass enclosures; (3) Stratoseal—solid ribbon compound for sealing fuselages for stratosphere flights; it is said to remain flexible in temperature range —70 to 150 deg. F.—AVIATION, *Nov.*, '43.

Sanding Disks 68

Heat resisting resin bond, reported to withstand high friction temperatures, is used to bind aluminum oxide grit sheets to pliable fiber backs of sanding disks made by **Fiber Abrasive Corp.**, Chicago. Capable of being cleaned for re-use, disks are supplied in diameters from 6 to 26 in. and all grit numbers.—AVIATION, *Nov.*, '43.

NEW PRODUCTS

Cabin Thermostat 69

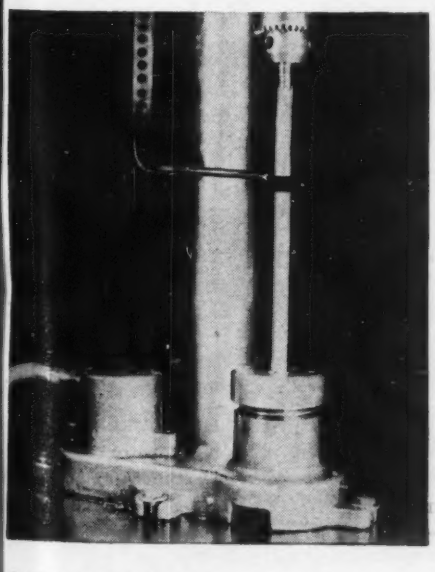
Bi-metal coil on flexing hinge composes temperature-sensitive element of thermostat for aircraft cabins. Entire assembly is suspended by spring on a bakelite base and enclosed in aluminum case which can be grounded. Duplex models for controlling dual heaters are available from **Barber-Colman Co.**, Rockford, Ill., which announces specifications as weight 7 oz. (duplex 14 oz.) and rating .5 amp. at 24 v. d.c.—AVIATION, *Nov.*, '43.

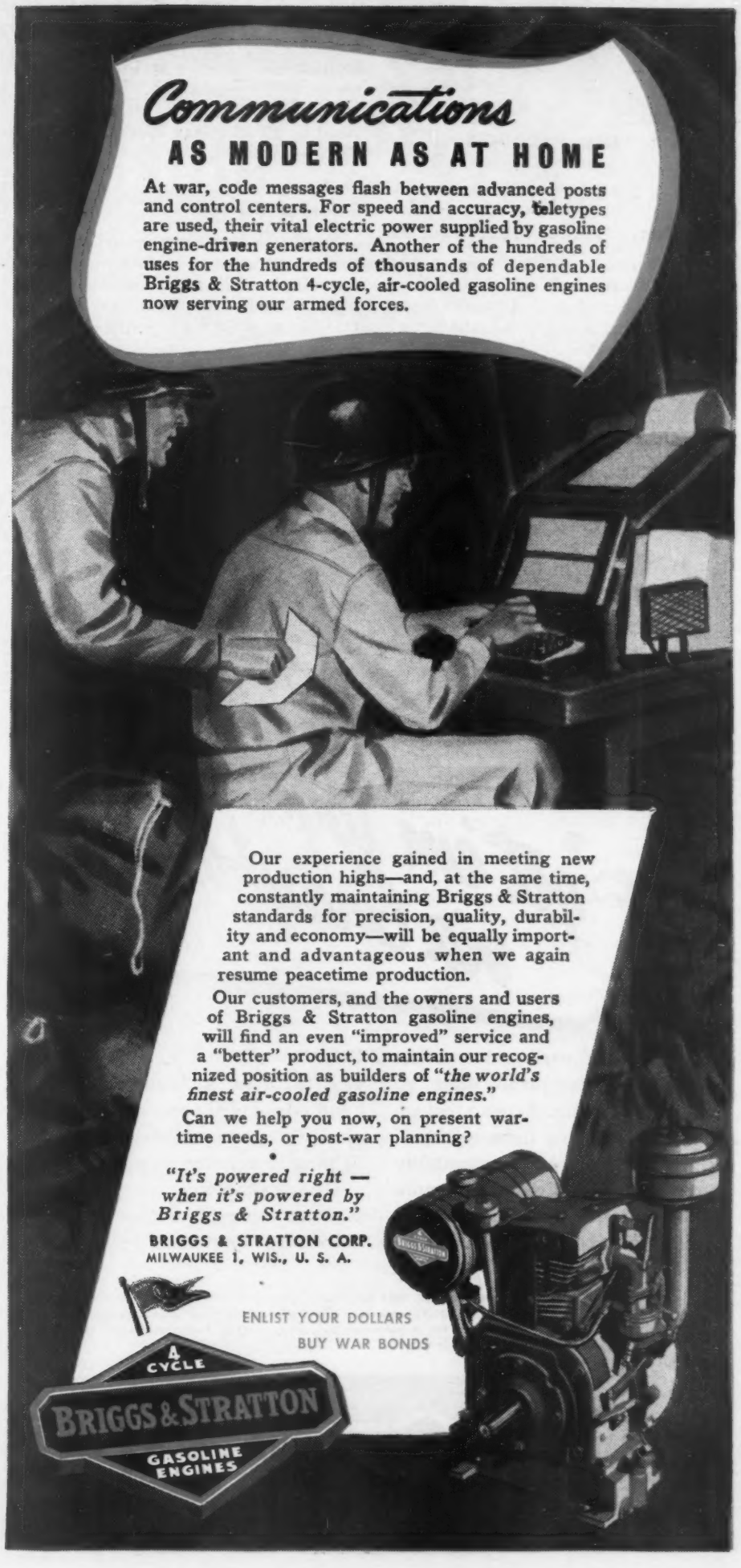
Radio Mounting 70

Ability to absorb vibration in any of three directions is reported to be feature of new aircraft radio and electrical equipment mounting announced by **United States Rubber Co.**, New York City. It can be used in as integral part of new equipment or incorporated in existing installation. Single mount will hold 6 to 12 lb.—AVIATION, *Nov.*, '43.

Air Chuck 71

Air-operated collet holding fixture for chucking machine screw parts for further work on drill presses, tapping machines, etc., has foot valve, permitting operator to load and unload with both hands. Device, manufactured by **Red-E-Air Chuck Co.**, Chicago, has Brown & Sharpe collets to chuck work in line with spindle despite variations in work diameter. Leverage action multiplies collet holding pressure to ten times that of air line. Size illustrated takes work to $\frac{7}{8}$ in. dia.—AVIATION, *Nov.*, '43.




Communications
AS MODERN AS AT HOME
At war, code messages flash between advanced posts and control centers. For speed and accuracy, teletypes are used, their vital electric power supplied by gasoline engine-driven generators. Another of the hundreds of uses for the hundreds of thousands of dependable Briggs & Stratton 4-cycle, air-cooled gasoline engines now serving our armed forces.
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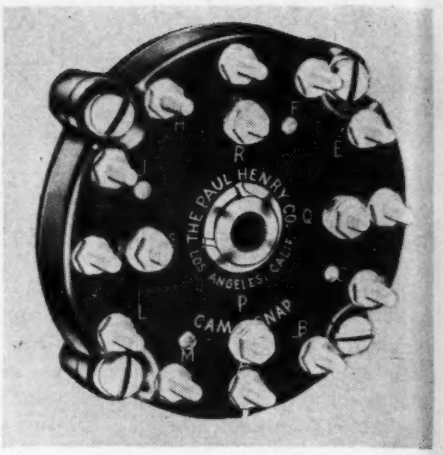
Actuator 72

Electric or hydraulic power can be used on actuator designed for cowl flaps, intercooler flap doors, oil cooler flaps, etc. Operating mechanism contains jack screw and reduction gear. Warranted loads are 1,400 lb. tension and 800 lb. compression. Device is 18 in. long at maximum extension, 5⅛ in. high, 5 in. wide, and weighs 8 lb. It is manufactured by **Pacific Gear Works**, Lynwood, Calif.—AVIATION, *Nov.*, '43.

Selector Switch 73

Snap-action selector switch for sequence operation of various aircraft accessories is made with from one to four primary and twelve secondary circuits. One or more of these switches can be mounted in a gang and operated by single shaft. They are constructed of macerated phenolic with enclosing case by **Paul Henry Co.**, Los Angeles, and weigh about 4 oz. each.—AVIATION, *Nov.*, '43.

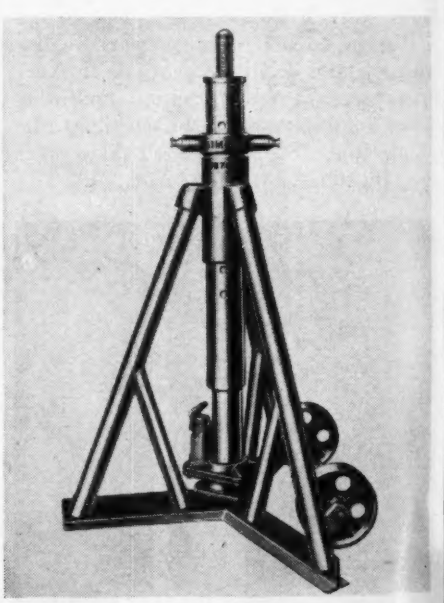


Ignition Files 74

Cards, 6½x9 in. containing an assortment of twelve ignition point files are being marketed by **New Britain Machine Co.**, New Britain, Conn. They are stated to be suitable for platinum and tungsten points.—AVIATION, *Nov.*, '43.

Hydraulic Jack 75

Features listed on new 10-ton wing jack produced by **Templeton Kenly & Co.**, Chicago, are center column lifting unit, safety retainer collar for compression loading, spherical base seat to prevent eccentric loading of hydraulic unit, and screw adjustment for micrometric leveling for instrument checking. Specifications: Minimum height 43¼ in., maximum height 74¾ in., hydraulic lift 24 in., screw lift 7½ in., and weight 265 lb. —AVIATION, *Nov.*, '43.



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GROUNDWORK

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With the war's end, this high ideal of aviation will be revealed. *Aviation will belong to everybody*. Even today, in war-busy aircraft plants, the plane you will fly tomorrow is taking form. A lot is known about its design, a great deal about its flying simplicity. Its economy of operation and moderate price is already taken for granted. Fleetwings is anxious to get that plane to you. That's one of the many reasons why Fleetwings is working so hard for victory.

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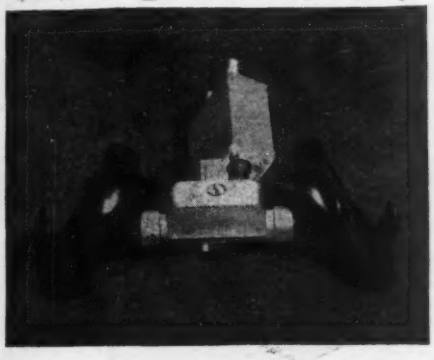


Fleetwings B2 J2 Gun Turret Valve

THE EXPRESSION "Production keeps rollin'," is true in more than one sense at Fleetwings for the mobile production lines that Fleetwings pioneered for producing parts are now being extended. Parts in process of assembly are moved along on wheels. This system makes it easy to move them from one line to the next and does away with the need of hoists and extra factory hands.

AUTHOR! Not entirely satisfied with available text books, Fleetwings is now preparing its own instruction books for its employee training. Instruction book number one, on the subject of drilling, is published, and already others are on the presses. In all, Fleetwings expects to supply its classrooms with at least five. These books, tailor-made for Fleetwings production, will improve efficiency.

In one issue of "The Arrow," Fleetwings' pocket-size monthly magazine, the reader is treated to this varied fare of timely and interesting subjects: pre-doping of wing surfaces, case hardening tools to speed production, vertical lofting boards that save plant space, illustrated news about Fleetwings' personnel, how to make a wing chord divider beam, and an introduction to a newly designed hydraulic valve.

You can enjoy "The Arrow" each month at no expense. Just send your request on your company stationery to "The Arrow," Fleetwings, Bristol, Pa.

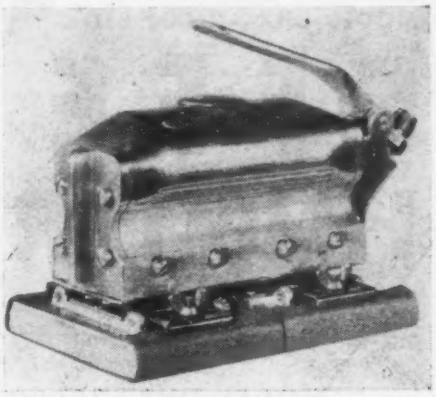
FLEETWINGS

Division of Kaiser Cargo, Inc.

BRISTOL • PENNSYLVANIA

Pneumatic Sander 76

Wide or narrow attachments are available for light-weight (6 lb.) high-speed (3,500 oscillations per min.) sander for use on flat, or curved abrading surfaced metal, wood, composition, or plastic.



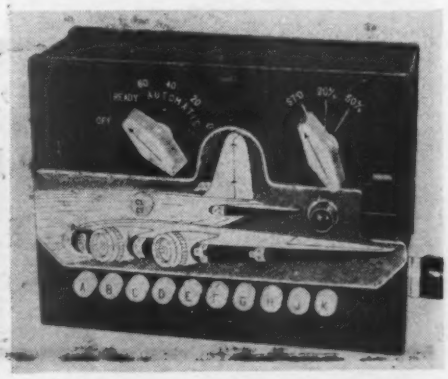
Gripping and releasing handle on top of machine starts and stops opposed vibration of pads. This type movement is said by **Sundstrand Machine Tool Co.**, Rockford, Ill., to eliminate vibration.—AVIATION, *Nov.*, '43.

Flap Controls 77

Designed for quick, automatic response, new line of hydraulic temperature controls for operating aircraft flaps has been brought out by **General Controls Co.**, Glendale, Calif. They have been made for warplanes, but are called suitable for commercial craft as well.—AVIATION, *Nov.*, '43.

De-Icer Control 78

Eclipse-Pioneer Div., **Bendix Aviation, Corp.**, Teterboro, N. J., announces electronic control for use with its manifold solenoid de-icer system and B. F. Goodrich boots. Control box (see photo) has illustration of plane with lettered sections (including empennage) which are connected to a similarly lettered row of buttons. Buttons and dials regulate intervals between inflation cycles and amount of air supplied to boots. Control consists of distributor valves located at each boot connection and actuated by electronically controlled solenoid; pressure oil separater; air filter; air pressure relief valve; and unloading valve for air pumps. Pumping is reported reduced to a minimum by single spanwise suction and pressure manifolds.—AVIATION, *Nov.*, '43.



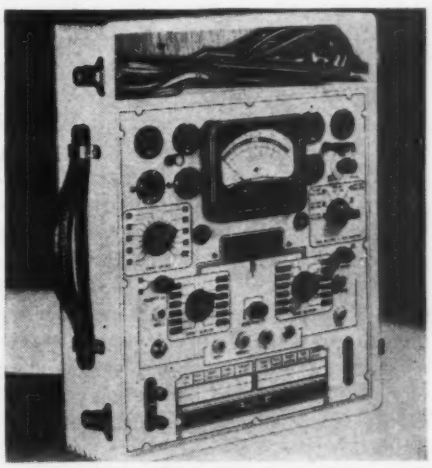
NEW PRODUCTS

Connecting Tool 79

Attachment for adapting standard compression rivet squeezers into tool for fastening its Sta-Kon electric terminals to all wire sizes No. 22 to No. 10 AWG is announced by **Thomas & Betts**, Elizabeth, N. J.—AVIATION, *Nov.*, '43.

Testing Unit 80

Model 804 dual tester is supplied by **Radio City Products Co.**, New York City, in case 14½x13x6 in. It weighs 12¼ lb. and is operated on 50-60 cycle 105-135 v. current supply for checking acorn and other types of radio receiving tubes and rectifiers. Ohmmeter reading ratio is 500,000,000 to 1; current reading ratio 1,000,000 to 1; voltage reading ratio 100,000 to 1; d.c. voltmeter range 0-25-10-50-250-1000-5000; a.c. voltmeter range 0-10-50-250-1000-5000; d.c. milliameter range 0-5-2.5-10-50-250-1000; d.c. ammeter 0-10; and ohmmeter 0-250-2500-250000-2.5 megacycles.—AVIATION, *Nov.*, '43.



Resonance Meter 81

Announced by **Erco Radio Laboratories**, Hempstead, N. Y., is new resonance meter reported suitable for use with absolute altimeters, glide path and blind landing markers, airport traffic control apparatus, and other radio and electric circuits and controls.—AVIATION, *Nov.*, '43.

Where are Those Dividends?

(*Continued from page* 190)

which have long been found desirable by conservative aircraft investors.

Curtiss-Wright has a Class "A" stock issue outstanding which comes in for a preferred rating. This stock was issued to the extent of 1,158,699 shares back in the late 1920's. Nominally entitled to a dividend of $2 per share annually, it was not until 1936 when the first payment was made—and then only 50c. per share. The same amount was paid during 1937, $1 in 1938, and the full $2 annually for 1939, 1940, and 1941. Thus far in 1943, $1.50 has been paid and it is fully expected that the remaining 50c. will be paid before the year is over. This issue is non-cumulative as to dividends and has suffered to a certain extent because of this condition.

Also mitigating against its early favor was the realization that it has no preference as to assets. Further, the Class "A" stock can receive more than $2 per share annually only after the same amount has been paid to the common stockholders, after which both classes of stock share equally. With 7,432,026 shares of common stock outstanding, this represents quite a hurdle.

Currently selling around $20 per share, the Class "A" stock of Curtiss-Wright affords a yield of 10 percent—as long as the full dividend rates are maintained.

Consolidated Vultee has a preferred stock issue outstanding. In a large measure this superseded the preferred originally issued by Vultee prior to the merger. Now outstanding in the amount of 216,729 shares, this preferred is cumulative as to dividends to the extent of $1.25 per share annually. This issue is also convertible into common at the rate of one and one-eighth shares common for each share preferred. Should the company elect to redeem this stock, it must pay $27.50 per share.

Currently operating in its favor is a strong sinking fund requirement which is designed to reduce the size of this issue over a period of years. Selling around $22 per share, this preferred affords a yield of better than 5 percent—assuming the full payment of the dividend in the future. Thus far these payments have been made when due. For 1942, this issue showed earnings of $66.29 per share.

Republic Aviation also has a preferred stock issue outstanding. However, this stock is closely held and is being rapidly retired.

Douglas Aircraft has shown a consistent dividend record but one completely lacking in liberality. Payments of $5 per share annually have been made

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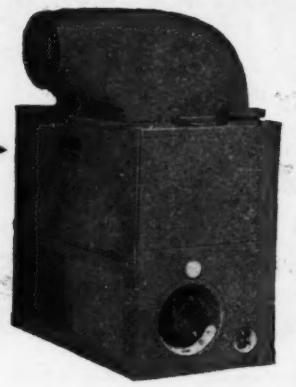
MODEL UH2—25,000 BTU



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Uses for Hunter Universal Gasoline Heaters are too widespread and varied to list completely, and are multiplied daily by the imagination and ingenuity of men who build, buy or command equipment for the service or supply of our armed forces, or essential civilian activities.

We build a variety of small, powerful units, each with a range of applications to which it is especially suited. YOUR heating problem may be one of these, or it may be one on which Hunter heating engineers can assist you in applying the extremely flexible basic units of Hunter Heaters to do exactly the job you need done. In either event, we shall be glad to furnish further information specific to your particular interests.

BULLETIN HB-3 ON REQUEST

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Aircraft Equipment

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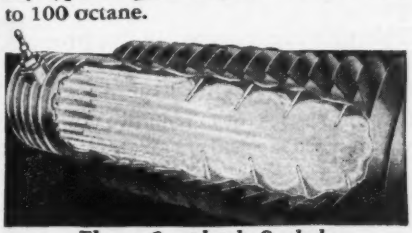
Engineers Aid Application of Universal Gasoline Burner to Armed Forces and Other Essential Services

FEATURES "SEALED-IN-STEEL" FLAME

CLEVELAND, OHIO—Growing demands for simple and efficient heating for mobile service units, portable housing elements and other special problems has resulted in the setting up of a special division of Hunter and Company of this city. The sub-division will work with designers, builders, purchasers or users of special equipment for the armed forces or for essential civilian services.

Success in the varied uses to which Hunter Heaters already have been applied resulted in this broadening of interest. This has been largely due to the extreme simplicity of the Hunter "Sealed-in-Steel" burner, the fact that it will "give out heat in a big way" from any type of gasoline, from truck fuel to 100 octane.



Flame Completely Sealed

The basic unit is a completely enclosed steel tubular burner, with highly effective areas of heat radiating fins. Atomizing, ignition and combustion take place within the welded steel chamber, the only opening being an exhaust, which can be piped to an outside vent. Hunter units for both heating and ventilation include small, powerful blowers, built into the compact heater casings. Heaters designed for operation from either battery or 110 volt current.

It would be impossible to list all of the uses to which the existing models can be put. Engineers with the armed forces and with companies building equipment are calling every day for applications hitherto undreamed of.

The basic principle is similar to the combustion of an automobile engine —just as simple, safe and sure. Models are made in 25-pound packages putting out 10,000 B.t.u. per hour or in larger models giving any amount of heat required. On heating problems in between or outside of the standard models, Hunter engineers stand ready to work with your engineers in fitting specific needs.

Requests for product information bulletin "HA-2" or for engineering data should be addressed to . . .

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(Advertisement)

for the period 1940 to 1943 inclusive. Prior to this period, $3 each was paid in 1939 and 1938. Going back a little further, this company disbursed 87½c. and 75c. per share for 1932 and 1933 respectively. Despite earnings of $30.29 per share in 1941, the indicated $5 was paid that year by the company. This is merely a reflection of the conservative policies of the company and shows how academic substantial earnings can be to stockholders in the aircraft industry.

Rewards from investing in the aircraft industry or any other new enterprise seldom come from dividend payments. It is the hope of material capital appreciation that leads investors to these groups. It is all a matter of timing. Those fortunate enough are able to participate in the capital growth of speculative enterprises long before their success is assured. The risks are great and many but the profits are large to the discerning.

The air transport industry is now passing through virtually the same cycle as that experienced by the aircraft industry in respect to possible dividend payments. The air carriers have, during the past few years, experienced outstanding earnings. The bulk of such profits, however, is being plowed back into the industry for future expansion and growth.

An outstanding example is that of Eastern Airlines. Despite earnings of about $12 per share since it was incorporated in 1938, Eastern has not declared a single dividend. According to its president, it may be inferred that disbursements in the immediate future are most unlikely.

The rest of the air transport industry can point to only token payments at irregular intervals.

It would be well for investors in both the aircraft and air transport industries to recognize the special circumstances surrounding dividend payment possibilities in these groups. By understanding the special conditions which are attached to growth industries, a more profitable investment approach may be made.

Design for Survival

(*Continued from page* 118)

Have the aircraft producers been guilty of stupid management to have built up such huge inventories? The answer can only be: Definitely not. They have simply been caught in the middle by circumstances beyond their control—caught between the need for vast overexpansion to do a job that had to be done, and the fact that present tax, renegotiation, and other laws, have prohibited the building up of any sizable amounts of working capital such as those being acquired in the automobile, steel, and other older industries.

It should not be inferred that the "preliminary design" seeks special favors or preferred positions in the matter of needed legislation, for no one knows better than the plane producers that those who seek such positions usually pay dearly for them. But contract renegotiation and termination are but two of the many problems which must be solved if America's No. 1 industry is to live more than a few weeks beyond the Axis' unconditional surrender. They are problems whose ultimate solution will depend upon Congressional action —action which can be guided by the industry which has so much at stake.

At the beginning of this war when the chips were down, the aircraft industry met the challenge with quantities of quality products. Today the chips are down again, this time calling for quantities of cooperation and quality of management to insure survival of an industry which is having an unparalleled part in speeding the enemy's unconditional surrender.

Engineers Made To Order

(*Continued from page* 169)

approached this acute problem by employing people from other industries who had been trained as civil, mechanical, or electrical engineers, and by instituting an orienting and training program to equip them for aircraft work.

An engineer enrolled in the orientation training group was first given an introduction to the various manuals, literature, and data used in aircraft. Following that, there was from three to four weeks training in aircraft drafting and engineering fundamentals. The engineer was then assigned to a design group where, step by step, he progressed from writing orders, making tracing changes, and drawing minor layouts to the more responsible assignments of layout design or engineering checking.

Results were highly successful. Vega was able to expand its engineering force from a nucleous of approximately sixty to three hundred in three or four months. Through this method of training, it was found that engineers from related industries could rapidly and effectively be oriented to the requirements peculiar to the aircraft industry.

However, that program was successful only because of the availability at that time of engineers from related industries. The training requirements now have changed greatly in view of the progressive unavailability of persons with even the basic background for engineering work.

(*Turn to page* 254)

IT IS THE Duty OF MANAGEMENT TO LOOK AHEAD

"It is an obligation for management to begin NOW to look ahead to the post-war years, when ability to produce at low cost will once more determine which plants are to survive. It is then that the plant that has been making full use of mechanical handling equipment will find that same equipment its sharpest-edged tool for cutting costs."
—Factory Management and Maintenance

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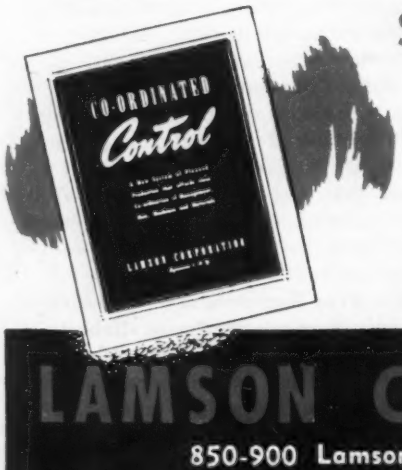

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In the early part of 1941, Vega, in cooperation with Lockheed Aircraft Corp. and California Institute of Technology, undertook an intensive training program designed to obtain for both companies highly qualified engineers capable of assuming responsible engineering and supervisory positions. The program consisted of an eight-week full-time course of instruction at Cal. Tech. in such subjects as aerodynamics, structures, strength of materials, mechanical design, and aircraft manufacturing methods. All students were paid regular engineering salaries by Vega and Lockheed.

Following this college session, the students were given a further intensive eight-week full-time training term in the Lockheed and Vega factories. This included actual experience in the solution of complex design problems on aircraft then on drafting boards. In addition, a series of lectures was presented by regular engineers on tool design, manufacturing, layout, materials, and structures. Upon the completion of the four months' program, the men were assigned to various jobs in the design engineering and manufacturing engineering departments of Lockheed and Vega.

This program resulted in the procurement for Lockheed and Vega of a large group of highly qualified engineers from other industries who might not have been induced to enter aircraft had it not been for such a training program. And this training tended to increase their confidence in their ability to step into a new field and carry out an assignment successfully.

Federal Assistance

Another type of training program was instituted early in 1941 when Federal funds were made available for short, part time, intensive courses to improve the skill and ability of persons working in the aircraft industry. The first attempt of Vega engineering to utilize such training facilities was through the University of California.

These courses consisted of highly specialized subjects directly related to the assignments carried on by students in their everyday jobs. For example, power plant design, aircraft structures, hydraulics, fluid mechanics, aerodynamics, stress analysis, and production design. A course was generally completed in 12 to 16 weeks, with classes meeting for two or three hours two evenings a week. They were considered quite successful in that they provided opportunities for employees of the engineering branch to improve their knowledge and skill by outside study. A large number of employees took advantage of these opportunities, and there is no question that many oc-

cupy key positions today largely as a result of this training.

In the latter part of 1941 and early in 1942, Vega continued to expand its engineering activities. At that time a rather acute shortage of experienced engineers, not only in aircraft but in related industries, became apparent. Coupled with this condition was the increasing problem of obtaining draft deferments for younger men.

Foreseeing the possibility of serious demands by the military forces for all available young men, Vega engineering branch undertook to encourage the training and employment of women in engineering positions other than the purely clerical and stenographic. In cooperation with the University of California at Los Angeles, Vega established a full time training program for draftswomen.

The University undertook this program after the company had guaranteed to employ a minimum of fifteen who completed the course. This guarantee was given in order to offer some incentive for those qualified to enroll. As a result, Vega obtained several women technical employees who are now occupying relatively responsible positions.

Late in the summer of 1942, Vega expanded its training activities. Several full time paid engineering training programs were established in conjunction with the University of California and the California Institute of Technology. Basic requirement for enrollment was draft exemption by reason of sex, age, dependents, or physical disability.

The first such program was organized in Santa Barbara, where seventeen men and women were accepted for a full twelve-week course. Later, other courses were instituted at Westwood, Los Angeles, Burbank, and Pasadena.

Through these full time paid training programs, Vega was able to expand its engineering organization quantity-wise approximately 100 percent in less than a year. Such an expansion involving relatively inexperienced persons created a pressing problem in that many occupations requiring high technical skill and ability were, of necessity, being performed by persons lacking proper qualifications. As a result, the load on supervisers became excessive.

To meet this problem, further paid training programs were undertaken. For instance, to develop qualified layout design draftsmen, night courses were established in which students attended one three-hour class each week for ten to twelve weeks. They were paid at established overtime rates. This initial program was considered such a success that other courses were established, and new ones are now being planned.

As the need for training courses has

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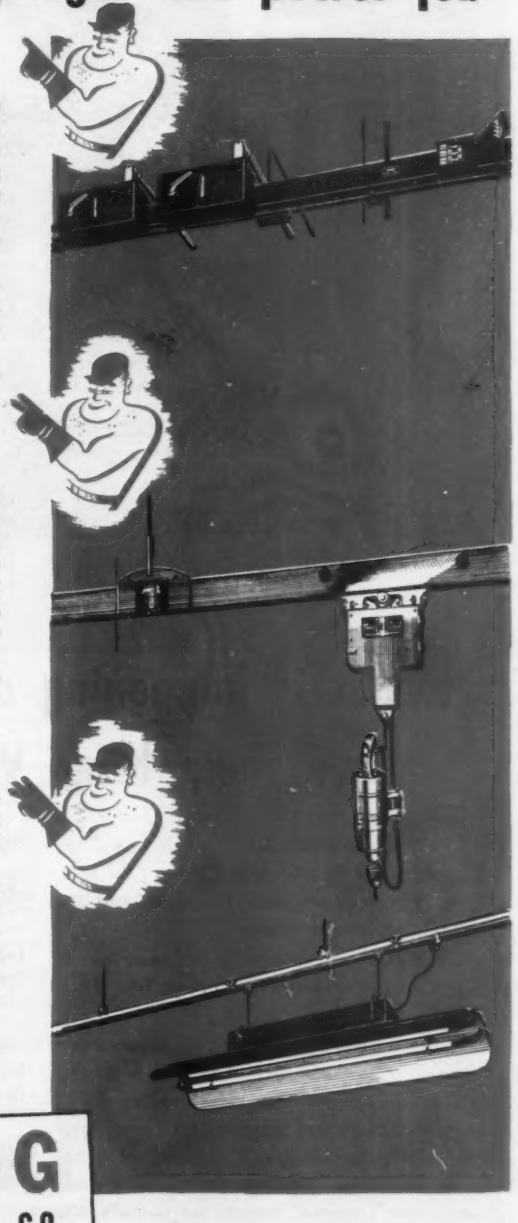

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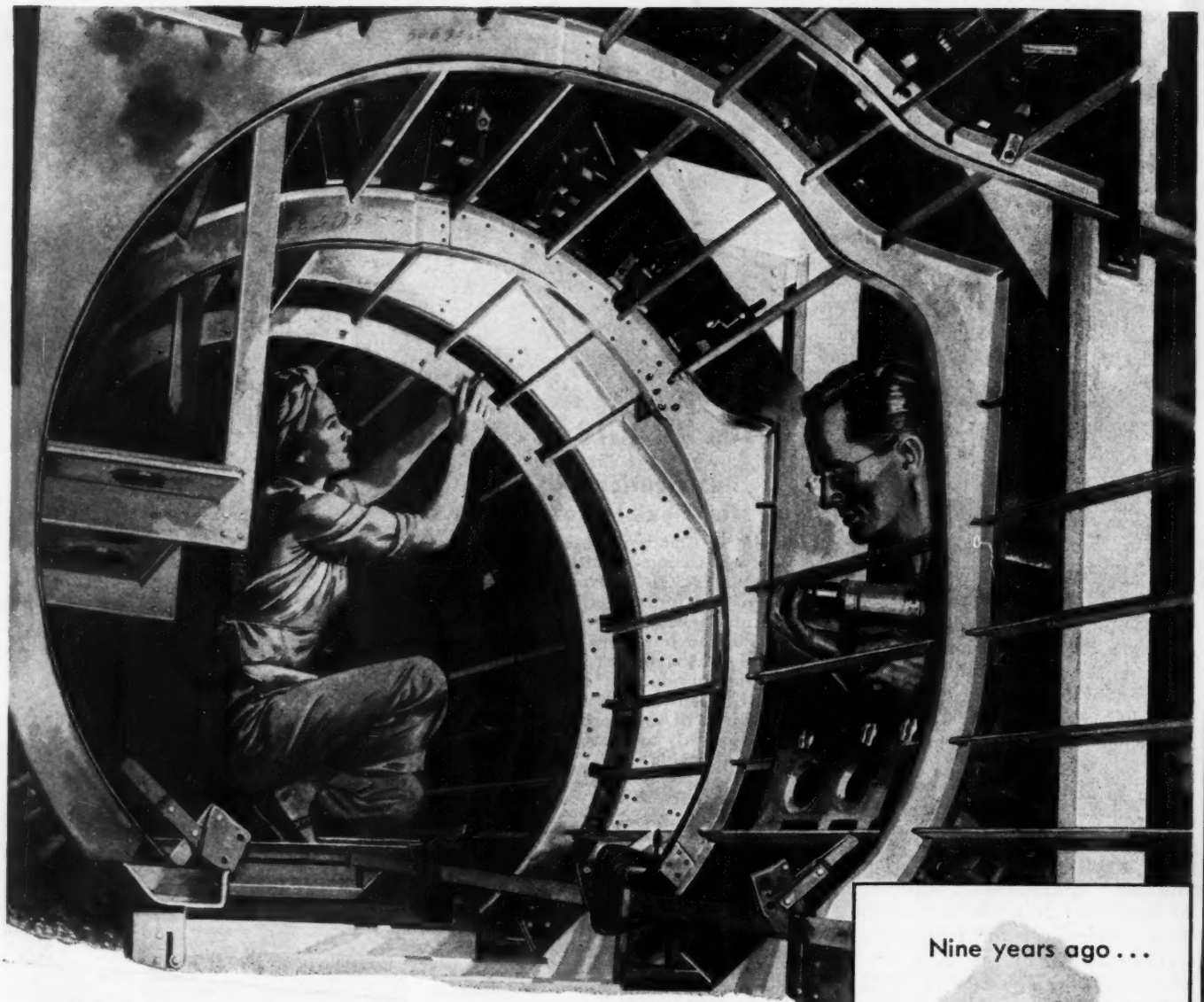

What is happening at Northrop today will help bring Victory sooner

'WAY BACK IN 1930... there was an airplane called the Northrop "Alpha"... the first all-metal stressed-skin monoplane to embody the multicellular wing structure.

The "Alpha" is important to America. It ushered in the era of the modern low wing all-metal monoplane.

Thereafter, the Northrop group created the Northrop "Gamma"—first airplane with the now-familiar split trailing edge landing flaps. Faster, even more aerodynamically "clean" than the "Alpha", the Northrop "Gamma" set trans-continental air-mail records. With military modification, ***the "Gamma" became the world's first airplane to be used as an attack bomber.***

This same Northrop group then built ***the Northrop 3A — pioneer pursuit plane flying over 300 miles per hour.***

Later, the group designed and built the N3-PB patrol bomber—still the swiftest military seaplane fighting on any front.

Such are some of the past achievements of the Northrop group—and that same group of Northrop talents is hard at work for America today. What is happening at Northrop cannot be fully discussed right now . . . but you may be confident of this:

Northrop aerodynamicists, production engineers and airplane-building craftsmen are turning out in production quantities new Northrop warplanes to carry on the tradition.

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In 1934, the Northrop group designed and built the Northrop 3A, pioneer of fighters flying over 300 miles an hour. To this low wing pursuit with its clean lines, retractable landing gear, and split trailing edge landing flaps may be traced the ancestry of many of today's fighters.

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arisen, Vega has met it with planned programs with long-range objectives. The newest full-time 52-wk. alternate training-and-work program in aircraft engineering fundamentals has been instituted to teach 40 selected members of the engineering branch to handle responsible technical and supervisory assignments.

In planning specialized training, the engineering branch made a careful analysis of requisite engineering subjects of college level. Consultations were held with representatives of California Institute of Technology on selection of courses that would offer a sound, practical understanding of engineering. Subjects chosen were condensed and pared to essentials.

At the start of the program, hydraulics was omitted, but after training was under way it was found that a condensed course was needed to round out the program. The addition of a basic, simplified course in electricity is being considered at the present time.

It is still too early for positive results, but Vega is confident that this type of training is a step in the right direction. At the end of the 52 weeks of the present course the engineering branch expects to have an additional nucleus of trained people whose understanding of engineering will be such that they can competently fill jobs requiring greater technical knowledge.

Engine Control Simplifies Piloting

(*Continued from page* 134)

RB and *TB*. The throttle control lever may be installed at either end of this shaft. Here, it is on the rear side of the unit, as can be seen from the portion of the lever visible above the housing. Shaft *B* of Fig. 2b may be seen below and to the right of shaft *A* in Fig. 4.

The lever at the left of Fig. 3 is for the mixture control. An added feature of this type of control is that it also automatically moves the mixture control from the "automatic lean" position to the "automatic rich" position when the manifold pressure is increased above the maximum value for cruising. This provision was made by attaching a cam to the mixture control shaft and operating this cam by means of a lever on shaft *A*. This lever and cam can be seen in Fig. 4, which shows the reverse side of the unit in Fig. 3. (It should be noted that there is no pin connection between this cam and its operating lever to the *T* link behind and to the left of the cam.)

Bosses for the shaft and servo piston connected to link *T* can be seen extending horizontally to the right behind the mixture control cam. Note that the

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throttle lever is in the closed position and that a recess is cut in the mixture control cam so that the mixture control lever may be moved manually to the idle cut-off position. This arrangement relieves the pilot of the task of adjusting his mixture control to give lean mixtures in the cruising range whenever his manifold pressure will permit such operation, and it makes certain that adequately rich mixtures are provided if he must suddenly open his throttle from the cruising to the high power range.

The small lever at the top center of Fig. 4 is to provide an over-ride control for emergencies in which greater than normal takeoff manifold pressures are required. It vents the capsule chamber to the atmosphere so that the control will regulate to the higher manifold pressure.

Advanced Auto-Control Units

Successful application of automatic control units to the throttle and mixture controls leads to consideration of how the ideal goal of a single-engine control lever in the cockpit might be achieved. Perhaps the next most important item is the propeller governor control. An additional cam could be easily provided on shaft *A* (Fig. 2b). It could be used to operate an additional lever on a hollow shaft concentric with and riding on shaft *B*. A lever at the end of this hollow shaft could be connected to the propeller governor. The cams could be contoured to cause the engine to operate along a propeller load.

If it were desired, the cam could be designed to make the power follow a constant manifold pressure curve for the cruising power portion of the range. The mixture control lever could be used to select whichever of the two curves were desired, or any of a series of curves intermediate between the two.

Fig. 5 shows the relation between horsepower and rpm. which would result for this type of unit, as well as the type of specific fuel consumption curves which might be expected. Note the important reduction in fuel consumption which the latter curves show for constant manifold pressure operation in the cruising range.

A supercharger gear shift control designed to meet the requirements of the engine could be incorporated in the main automatic control.

Although both the maximum power and the minimum specific fuel consumption characteristics of an engine can be improved considerably by using a variable spark advance, the complexity and inherent error of mechanisms heretofore available have been such that virtually all American aircraft engines have employed a constant spark advance. Fig. 6 shows a typical curve for

(*Turn to page* 299)

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The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington — HERB POWELL, New York

Nazis May Not Have a Good Defensive Roof, But Their Air Force Has Plenty of Fighters

Washington (AVIATION Bureau)—President Roosevelt summed up the air war recently when he said that Hitler had neglected to put a roof on his European fortress. Total combat airplanes so far put into action by the AAF against the Nazis cannot be printed, but it is surprisingly small compared with US industry's output. Thus, the major weight of Allied airpower has yet to be brought against the enemy.

The Luftwaffe no longer hopes to take the initiative, nor will it try. Goering stopped producing bombers last December. But German fighters of good quality are coming out in such large numbers that they are inflicting heavy losses, especially upon US day attackers. All of the facts concerning AAF bombings cannot be published. One day recently Allied airmen put down 152 Nazi planes, but those days are few and far between.

Nevertheless, the Nazis are being mortally hurt from overhead, as indicated by their agonized squawks over shortwave radio. Still Air Force officers fret because they have actually knocked out very few Reich vital points, yet they believe that Allied air punishment may possibly break the Germans down unexpectedly. As near as one can interpret the off-record opinions of returned observers, Allied intentions are to spend the winter battering German production and morale in preparation for new invasions in the spring.

Under Secretary of War Patterson says that since July, German plane losses have been greater than production. Army Intelligence officers report that the Luftwaffe is stronger now than it was in 1939. These seemingly contradictory statements could both be true. The sum of it is that Germany recently had 5,000 planes on the line and 5,000 in reserve. But the shift from bombers to fighters makes more units, so the total might now be greater. Unfortunately, one enemy fighter can destroy a vastly more costly heavy bomber.

It is true that time plays into the hands of German fighter producers, but every week of Allied advance in Italy brings more Nazi objectives within bombing range.

Some American *Liberator* squadrons, transferred from England to North Africa, may be the forerunners of a heavy force which will use the fair Mediterranean weather for a winter campaign into Southern Germany and her Balkan lands which have hitherto been beyond reach. Recent shuttle raids by bombers passing between England and the Mediterranean bases may be significant too.

Unofficial but persistent opinion from London says that after a period of maximum Allied bombing invasion may not need to be the bloody conflict usually envisioned.

Results of strategic air attack (independent air war) are hard to calculate, but there is little doubt about the work of tactical aviation. Gen. H. H. Arnold, Chief of AAF, said Salerno could not have been taken without air assistance. Allied squadrons raked the ground so thoroughly that the heaviest Nazi counterattacks were thrown back with much less than expected losses. If AAF and RAF can keep superiority over German fighter defenses, it will make a world of difference when Allied land forces tackle the Huns on their own ground.

President Roosevelt, greatly pleased with the capture of Foggia and Naples and the advance on Rome, said that we face a hard fight up through Italy; that overwhelming forces must be accumulated in Britain; that the Japs hold a strong line from the Kuriles thousands of miles south to Malay, Burma and China, and that we will have to hit them hard at many points.

The Japs, like the Germans, are shifting to production of defensive fighters because they are consistently beaten by the Allies in the air in such defeats as those at Lae and Finschafen, both of which were serious. At Wewak our forces destroyed about 60 Jap planes in one day, with losses reported to be small.

CATERPILLAR NO. 1

Country's first Army pilot to save his life via parachute—thus becoming No. 1 member of Caterpillar Club—Col. Harold R. Harris receives Switlik Trophy commemorating jump on Oct. 20, 1922, at Dayton, Ohio, during days he was chief of McCook Field flying section. Left to right, Harold L. Foster, Caterpillar Club president; Col. Harris; and Stanley Switlik, of Switlik Parachute Co.

War Department Gives Out Some Uncomfortable Facts

Washington (AVIATION Bureau)—For months warplanes have been number one on the Army's weapon priority list. Experience at the front now puts them "first, second and third."

For that reason—and because of the manpower bottleneck on the West Coast—the War Department last month called a "conference of industry, labor and the press" to bolster fighting spirit among plant managements. Nearly all aircraft production presidents attended the meetings in the Capital.

The gist of what they heard was that the Nazis are retreating, but they are concentrating their forces in smaller areas, which makes them stronger. Last December they stopped production of bombers entirely and moved over to defensive fighters. As a result they have fighter superiority over some Allied targets in Europe.

To beat down fighter resistance and soften Europe for invasion, the Army wants (1) more and more heavy bombers; (2) rapid progress toward full production of the B-29 super-bomber; (3) large numbers of long-range fighters; (4) faster training of bomber crews.

The manufacturers were shown motion pictures of tremendous Allied losses of materials; they were told of heavy aviation losses, the nature of which cannot be published lest it help the enemy. A grimly realistic sham battle was staged for them at Fort Belvoir, a few miles from Mount Vernon, Va.

There are about 250 vital objectives, cities, transport centers, harbors, air bases, etc., in Germany which must be bombed out. So far we have crippled perhaps 25 of them, and completely knocked out much fewer than that.

Some manufacturers told the Army it should put the show and the conference on tour so it could be seen by workers who are not doing their best and by labor leaders who are "dragging their feet."

Manpower, Design Changes Slow Production, But Efficiency Pushes Plane Rate Near 8,000

Washington (AVIATION Bureau)—Manpower shortage and design changes are still primary limiting factors on warplane production. There has been no major material shortage reported to the War Production Board for many weeks.

With aircraft spearheading the war on all fronts, Army and Navy took the West Coast manpower shortage most seriously and went to the President for a remedy. Result was that James F. Byrnes, first assistant to Mr. Roosevelt and Director of War Mobilization, directed the promulgation of the West Coast Manpower Program, which aims to let WPB schedule aircraft production on the basis of labor availability as directed by the War Manpower Commission. This is done through "area of production" and "priority" committees. Eight federal agencies are involved, and the industry finds itself under a changed and complicated method of dealing with the government.

WPB officials admit that labor does not like the plan because unions fear a heavy shift of workers to aviation from other industries they have organized. They fear that high-rated jobs will be scaled down. The Coast doesn't like it because it is felt that many non-aircraft war contracts will be canceled to release more workers. Some have already been terminated. Management dislikes the closer relationship with WMC.

Practically nobody likes the Byrnes plan. But so long as the administration thinks it will work, all express willingness to abide by it.

Shortly after this plan was promulgated, the East and West Coast Aircraft Production Councils met in Washington and agreed that teeth should be put into the War Manpower Commission's "job release" regulations, so as to curtail labor turnover, which in some plants is at the rate of 100 percent per year; that draft of experienced men from aircraft should be stopped; that the Army should release key aircraft men already drafted. No mention was made in the council's official resolution on the Byrnes plan.

Aircraft production has been running around 7,600 per month for four months, whereas the Army-Navy-WPB schedule calls for a rate in excess of 8,000 by now. WPB officials still hope we will build 90,000 planes in 1943, but authorities in the industry estimate 80,000 to 85,000. The 1944 quota is 115,000, which will be more than half of the entire war production program; the industry is pledged to meet it, but doesn't know just how it's going to do it.

The industry feels that it is unjustly accused of inefficient use of manpower. Donald Douglas, speaking for Coast producers, said that in the first seven months of this year when employment increased only 4.4 percent, production of planes increased 44 percent. In other words, in July every aircraft worker was turning out what it took two workers to produce last January—a 100 percent increase in six months. Mr. Douglas quoted figures from other aircraft companies showing an efficiency improvement of many hundred percent since 1940.

He denied also that the cost-plus-fixed-fee type of contract makes inefficiency profitable. He pointed out that the fee does not rise as costs increase. On the other hand, he said, disallowances by government auditors increase as costs increase.

The industry also denies that it is hoarding labor. It is explained that irregular deliveries from sub-contractors and unavoidable dis-balances in production, due to design changes and other causes, are bound to lay off sections and crews, which it would be folly to discharge.

Not much of anything can be done to alleviate the burden of design changes. Total losses due to these changes approach 1,000 planes per month. However, those planes delivered are much more effective at the front. Some models have been so radically redesigned that the enemy at first failed to recognize them at all.

It is true that the armed services are reducing the number of types. But offsetting this are the increasing complications of existing models and the constant demand for introduction of new ones.

There will be a new crop of design changes when we go after Japan.

Chamber Offers Services On Postwar Problems

"The continued welfare of the US in attaining victory in this war and in keeping the fruits of victory in the future depends in large part upon the maintenance of a strong air arm backed by a sound aircraft manufacturing industry."

This platform was recommended to the Aeronautical Chamber of Commerce after a three-day meeting of its economic development committee in Colorado Springs.

Other recommendations, announced by chairman S. W. Voorhes, of Lockheed, were legislation and declaration of national policy on contract terminations "with the objective of tapering off war production with the least possible shock to the national economy"; cooperation with the government in postwar plant disposal; and dissemination of data on all problems affecting the industry for the information of Congress and member companies. The committee also recommended offering of the services of chamber technical and industrial organizations in postwar disposal of warplanes.

An executive committee of 15 was established within the Economic Development group with Voorhes as chairman. It was not said what the work of the new committee would be.

TWA Names Writing, Photographic Winners

TWA's sixth annual aviation writing and photographic winners this year are: Robert S. Ball, Detroit *News*, first place in the open newspaper division; Scholer Bangs, formerly with the L.A. *Examiner*, second place for his work on that paper. He is now West Coast editor of *Air Transport* and *Aviation News*. R. M. Cleveland of the New York *Times* won third place.

Alexander McSurely, former aviation editor of the Dayton, Ohio, *Journal-Herald*, won first place in the newspaper division of under 100,000 circulation. He is now with McGraw-Hill's AVIATION, *Aviation News*, and *Air Transport* group. Nick Moser of the Reading, Pa., *Eagle-Times* placed second; Helen Waterhouse of the Akron, Ohio, *Beacon-Journal*, third in the Under 100,000 Class.

In the magazine division, Max Karant, managing editor of *Flying* won first place; E. J. Foley of *American Aviation*, second; and Selig Altschul of *Barron's*, third. The photographic awards were won by William W. Dyviniak, staff photographer for the Buffalo, N. Y., *Courier-Express*, first place; W. E. Loeber of the Pittsburgh *Sun Telegraph*, second; and Robert Seelig of the New York *News*, third, his second award in this class.

BRISTLY GOATEE

New punch added to Flying Fortress chin is a turret with two .50 caliber guns which Wright Field has called "the finest arm of its kind in the world." This gun, says one arms engineer, "is capable of firing 850 shots per min. and weighs about 65 lb. The projectile, leaving the muzzle at a speed of more than 3,000 ft. per sec., is capable of penetrating any and all parts of an airplane, including the engine itself." (Wide World photo.)

★ MILITARY MEMOS ★

The distance between opponents in the race of offense and defense is narrowing again. Although Col. Samuel Anderson, chief of the *Marauder* force in Britain, reports that coastal bombing has forced Nazi fighters to move further inland on the Continent, the *Luftwaffe* is still uncomfortably strong. In raids, AAF B-17's and P-47's were knocking down 100 or more Nazis—but losing 30 or more planes themselves, a potent footnote to the government's complaint that production is still not high enough.

One reason for the losses was the as yet not fully described enemy rocket propelled weapon. It struck one *Fortress* with a 10-lb. piece of metal 4 in. thick and 14 in. long.

"Fortresses" themselves were being improved. Bomb loads have been increased, and on a 600-mi. roundtrip to Emden, on which they were escorted by P-47's, they carried about 4 tons each. Here precision bombing was discarded in favor of the British saturation tactic.

"Chin" turret (see photo) with two .50 caliber guns was also being installed on B-17. Describing bombing formations, which he said were led by *"Fortresses* which carry no bombs but are equipped with 30 superheavy machine guns and many cannon," a wide-eyed German war reporter was said to have calculated that in larger formations "more than 1,000 US airmen, covered by armored planes, are defending themselves with more than 3,000 machine guns and cannon." This piece of arithmetic seemed to be substantiated more by awe than by accuracy—and soothing propaganda.

Adaptation of P-47's for 300 mi. raids, such as the one on Emden, indicated that the high command does not regard our own gunpower as highly. Or, in other words, German defenses were stiffening mightily.

The Nazis, however, were unable to pin ex-movie love maker Capt. Clark Gable's ears back. Leaving his gun, he started back to this country on a new assignment decorated with the Air Medal "for exceptionally meritorious achievement in five separate bomber combat missions."

Weight of bombs dropped per minute by RAF has increased from 17½ to over 50 long tons in past 16 months. "The havoc wrought is indescribable," Winston Churchill told Commons.

Invasion of Italy "would have been easier with more planes," says AAF Commander Arnold.

Camera Proves It

American aviators will be able to confirm victories by means of a gun-sight aiming-point camera which photographs on movie film everything within the gunner's range while the gun is firing. Installed in many fighter and bomber planes, it weighs 2 lb., measures 4 by 6 in., and costs $290. Camera has its own motor and holds 50 ft. of 66 mm. film.

Army credits Corp. Fred Behm, instructor in armament at the Yale AAF Training Command School, for the development.

"It could not have been done with less."

Maj. Gen. Claire L. Chennault, commander of Fourteenth (China) Air Force reports that Jap air strength at Haipong, Canton, and Hong Kong has increased 200 to 300 percent in the past month. "Their planes have improved in performance this year. The crews give every evidence of being well and carefully trained. They show the greatest courage in combat. The easiest way to defeat the Japanese is from China bases."

In three years, firepower of Navy planes has increased five times and battleship anti-aircraft 100 times, according to Assistant Navy Secretary Stevenson.

Maps of enemy defenses have already been prepared from the air for the men who will soon invade the Continent.

War Dept., says Gen. Arnold, in announcing easing of the 24-hr. air warning service, "is assuming the calculated risk that the small-scale air attack of which the enemy is now capable may meet with some measure of success."

★ SPOT CHECKING ★

In the Services: New Chief of Navy's Bureau of Aeronautics is Rear Adm. DeWitt C. Ramsey . . . Succeeding Maj. Gen. Ralph Royce as commander of First Air Force is Brig. Gen. Frank Hunter, World War I ace and first air commander to put a P-47 in action. . . . Col. Edward J. Timberlake, Jr., who led a Liberator group in the Ploesti oil field raid, has been made a brigadier general. . . . Distinguished Flying Cross "for extraordinary achievement in aerial flight" has been given Maj. Gen. Claire L. Chennault. . . . Col. James G. Hall is now chief of reconnaisance branch in the office of the assistant chief of air staff for operations. . . . Maj. Gen. Davenport Johnson is commanding 11th Air Force in Alaskan area.

By 1950, 500,000 planes will be crossing American skies, in opinion of William A. M. Burden, special aviation assistant to Secretary of Commerce. There will be 441,000 private, 50,000 military, and 9,000 transport, he ventures.

Intrastate service over five routes within New Jersey has been proposed by Otto Aviation Corp.

Grover Loening, WPB consultant, applies some political theory to arguments over postwar routes: "In the domestic and international field we cannot have a monopoly because we are a democracy—because it is against the very things we are fighting for."

"Monopolistic control of U. S. international air services is not favorable to prompt and progressive aviation development in the public interest," says a report submitted to the directors of the Chamber of Commerce of the US.

New Battleship Trend?

The famous Battleship X, the new *South Dakota* which beat off scores of Jap planes and shot down 32 of them, was bristling with many more than the usual number of anti-aircraft guns and carried special armor. Her success against aircraft has given rise to authoritative suggestions that battleships could be converted from big sea gun platforms to anti-aircraft fortresses with hundreds of guns. These would throw steel so thick that few if any attacking aircraft could penetrate it. Such ships would accompany and defend aircraft carriers.

But this possibility ends like all military schemes: The enemy can do it, too.

Canadian Notes

By James Montagnes

Establishment of landing facilities in communities across Canada is the first step in postwar air planning undertaken by the Aeronautical Institute of Canada, President C. R. Patterson stated recently at Toronto. "Safer planes for private owners will open up new sources of employment," he said. "There will be local flight-training schools, air taxis, sales, and repair services, flying ambulances, and fishing and hunting trips by air. Fresh fruits, fish, and other perishables will move by air. All first class mail will be airborne. A large proportion of the 300,000 men and women under 30 in the Royal Canadian Air Force and Canadian aircraft industry will want to remain in the industry when the war is concluded."

Development of a chain of airfields in northwestern Canada, from the United States boundary to Alaska, has reduced the need for floats and ski landing gears. Wheels can now be used the year round on many of the war-emergency fields hacked out of the bush on the northern routes. The seasonal change-over from floats to skis is becoming a thing of the past. Only on routes off the main wartime airways do operators still have to make lake-landings summer and winter. Wartime cargo demands required the building of airports since floats and skis reduce payloads.

Broken plastic airplane windows are being used in the RCAF to make medical and dental equipment formerly formed from steel and brass. Capt. Joseph Freeman, RCAF dental officer, and Warrant Officer Wilbert Mitchell, RCAF dental technician, have developed methods for using perspex window material in splints and in headcaps, necessary in plastic surgery to hold broken jaws.

New Trans-Canada Air Line services are planned between Montreal and Halifax and from Winnipeg to Edmonton. The government has earmarked $560,000 for the development of these two routes, with $200,000 to be spent on the Montreal-Halifax run for airport and radio facilities at Blissville. No date has been set for the commencement of operations of these routes.

Three new buildings are under construction at Stevenson Field, Winnipeg, by TCA, including a new brick and steel hangar, a hangar annex,

The Washington Windsock

By BLAINE STUBBLEFIELD

People are asking: What happened to the Navy's liquid-cooled engine, announced months ago? Regardless of that, there's another one now and it's away beyond the talk stage.

Mayor LaGuardia and staff, now planning a system of airfields for the New York region, have blueprints calling for some roof-top runways to be used by shuttle services.

Several hardshell admirals rejected the proposal of auxiliary aircraft carriers one year ago, but the Navy board approved. Maritime Commission got the construction program because it had facilities available.

British ship companies have a lot of money to buy airplanes—if their government would let them. They got the money from insurance firms on account of submarine sinkings.

Will Russia give air bases to the US from which to hit Japan? Your answer is as good as ours, but the Russians *have* refused Jap overtures for a peace guarantee. Muskovites are going along with us as best they can while still keeping clear of war with Japan.

Now is the time for private flying organizations to give a hand at rewriting their section of the Civil Air Regulations. A man who ought to know says the board and the administrator are in the mood for it.

The Truman Committee is writing a transportation report which will carry some aviation stuff. Which should remind you to look for more talk of an over-all transportation department in the government.

If successful lobbying depends on size of budget, the railroads must win. There are two or three score of single railroads bigger than the whole air system. Airline men say they are willing to fight the rail men but would like to fight the war first.

Communications Commission has criticized Western Union for failure to make specific plans for speed and price standards to meet competition of the telephone and airmail. The latter will be hard to catch up with when it gets going again.

Considered opinion of many aviation people here is that the Civil Aeronautics Board is asserting less authority—conforming more to Administration orders. If this is true, the possible outcome would be eventual creation of a supercommission of some kind, leaving the board a mass of technical and clerical duties.

and a service building. Cost is set at $400,000. While the hangar and annex will be used by MacDonald Brothers Aircraft during the war, it will revert to TCA afterwards.

Department of Transport, Ottawa, has started work on a new international airport at Fort William, Ont. It will cover about 300 acres and be equipped for customs and immigration clearance of planes and passengers.

The government has leased 200 sq. mi. of the Goose Bay area of Labrador for 99 yr., according to a report in the Toronto *Financial Post*. The arrangement, in which the Newfoundland Commission and the British government are parties, provides that after the war consideration will be given to extending the lease to cover civil as well as military rights. Canada has spent $15,000,000 building an airport at Goose Bay.

Changes in detail design and flight operation methods resulting in safety and regularity of schedules will be primarily responsible for postwar expansion in air transport, James T. Bain, TCA chief engineer, told a recent Toronto joint meeting of the Engineering Institute of Canada and the American SAE. There will be no revolutionary changes in plane structures and sizes for some time after the war, he predicted.

Canadian National Railways has registered opposition to the application of Quebec Airways (subsidiary of Canadian Pacific Air Lines) for a service to the Saguenay River region. Request for such service was made by the Aluminum Co. of Canada, Foundation Co. of Canada, and J. L. E. Price Co., the firms claiming that railway service was not adequate in the face of war emergencies.

Aircraft Minister Howe revealed that 14 radio range and communication stations have been built, 7 additional ones are nearing completion, and construction of another 16 is planned in '43. He stated that for civil aviation, meterological and radio divisions a total of $100,000,000 had been spent on 286 projects, including construction of 146 new airfields.

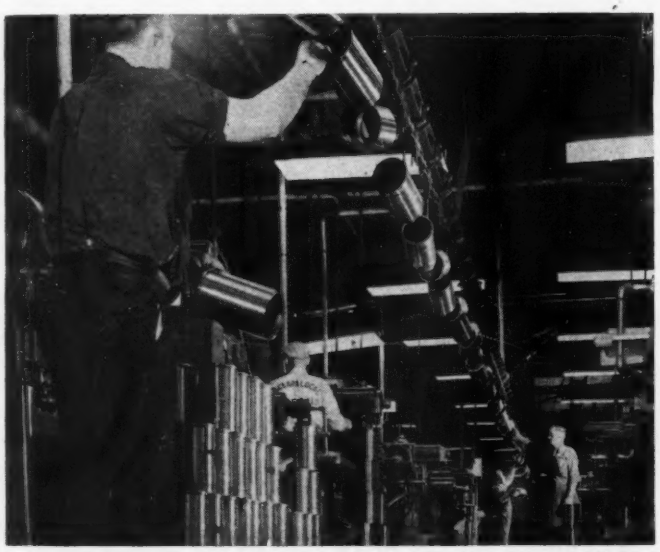
By F. H. Fullerton

Construction of a huge test flight hangar for Canadian Pacific Air Lines is well under way at Municipal Airport, Vancouver, B. C. The building, 264 ft. long. 120 ft. wide, and more than 50 ft. high will be used to store and equip planes being tested.

Approximately 3,500 Boeing Aircraft employees in Vancouver, B. C. plant will receive wage increases of 6-7c. an hour, retroactive to July 15, 1943, it is announced by Boeing management and Aeronautical Lodge 756 officials. It is estimated the increase will amount to an estimated $1,960 a day, or $54,880 a month.

Women are not responding to Boeing's invitation to work at its Vancouver plants. Housing was found for 600, but only 60 took advantage of the offer.

Powell River Co., Ltd., will shortly begin the assembly of certain small parts for Boeing bombers at Powell River, B. C.



MOTOR MAKER'S METHOD

Packard engineers have incorporated automobile production methods into the manufacture of Rolls-Royce engines. Here cylinder liners proceed through various machining departments on an overhead conveyor. (Press Association photo.)

★ Calling Names ★

With the retirement of **Richard A. Von Hake** as vice-president in charge of Lockheed manufacturing, **Courtlandt S. Gross** has been made company vice-president and general manager; he will also retain the presidency of Vega. **Harris McIntosh,** former Vega production control director, has become special assistant to Lockheed Pres. Robert S. Gross in charge of management and organization control and scheduling. Von Hake had originally planned to retire Jan. 1, stated Pres. Gross, however "organization changes which would have taken place at the end of the year have been made now" to correspond with new production schedules.

John J. Ryan, Republic Aviation Corp. counsel, is elected a vice-president of the firm.

Justin A. Fitz, connected with Sperry Gyroscope for the past 26 yr., is appointed advertising director.

United Air Lines named three new area managers: **Clarence H. Bennett** at Oakland; **Glenn W. Evers** for Northern Chicago, and **Burton C. Koenitzer** at Philadelphia.

Robert S. Maurer, formerly of CAB, is named assistant to **H. R. Bolander, Jr.,** general counsel of Chicago & Southern Air Lines. **R. Todd Crutchfield** is appointed assistant to general manager of the company's modification center, and **H. Lance Forsdick** will manage the new employees' cafeteria.

Thomas A. Morgan, Sperry Gyroscope president, has accepted appointment as chairman of the aviation group of the N. Y. Committee of the National War Fund.

Clifford H. Collins, project engineer for Kinner Motors, is named asst. chief engineer.

Lowell E. White, formerly test pilot for Wright Aeronautical, has joined the research engineering staff of the C-O-Two Fire Equipment Co.

Delos M. Palmer, dean of engineering at the University of Toledo since 1934, has been appointed plant engineer at American Propeller Corp.

J. H. Tudhope is appointed executive assistant of ICA, headquartering in Montreal.

Northwest Airlines announces the appointment of **J. Harold Foster** as superintendent of its military aircraft modification project. **R. E. Remund** is named asst. supt. in charge of production: **H. G. Hougland** became asst. supt. in charge of administration, and **W. W. Corder** has been named asst. supt. in charge of production planning.

C. George Evans, personnel director of Air Associates, has been appointed a panel member of the regional WLB.

Capt. Jess E. Hart, Continental Air Lines pilot, resumes his duties as a major in the Army, temporarily terminating nine years of continuous service with the airline.

UAL's **Lee Hegglund,** of its Cheyenne maintenance base, won WPB's top award, Certificate for Production Ideas, for his development of two devices used in United's engine overhaul work. Two other UAL employees won honor awards.

John Dolza and **Harry C. Karcher,** Allison division, General Motors Corp., were awarded the Manly Memorial Medal of the SAE for contribution to progress in aircraft engine lubrication.

Dr. L. G. Lederer, for the past several months acting chief of PCA's medical department, is appointed director of the department.

Joseph J. Mitchener, Jr., former superintendent of CAA's War Training Service in the 2nd region, is appointed advisor and head of development division for Hawthorne School Flight organizations.

John Splain, former N. Y. Commissioner of Motor Vehicles, is appointed director of purchases for Hub Industries, Inc.

Ray W. Wells, TWA eastern division chief pilot since 1942, was named superintendent of TWA's newly created Midwest division. **Walton H. Smiley** was named to succeed him as chief pilot.

J. Francis Reilly has been appointed executive assistant to **CAB Chairman L. Welch Pogue,** succeeding **Robert B. Bias,** who joins Lockheed Aircraft's Washington office in an executive position.

William Martin Grampp, former director of purchases for Brewster Aeronautical, has gone with the Black Bear Co. as general manager.

Emil (Eddie) O. Schramm, Jr., has joined Clarostat Mfg. as purchasing agent.

Arthur J. Dickinson, formerly group engineer in charge of hydraulics design and installation on the *Mars* for Glenn L. Martin, has been appointed hydraulics design supervisor for Simmonds Aerocessories.

★ ASSEMBLY LINES ★

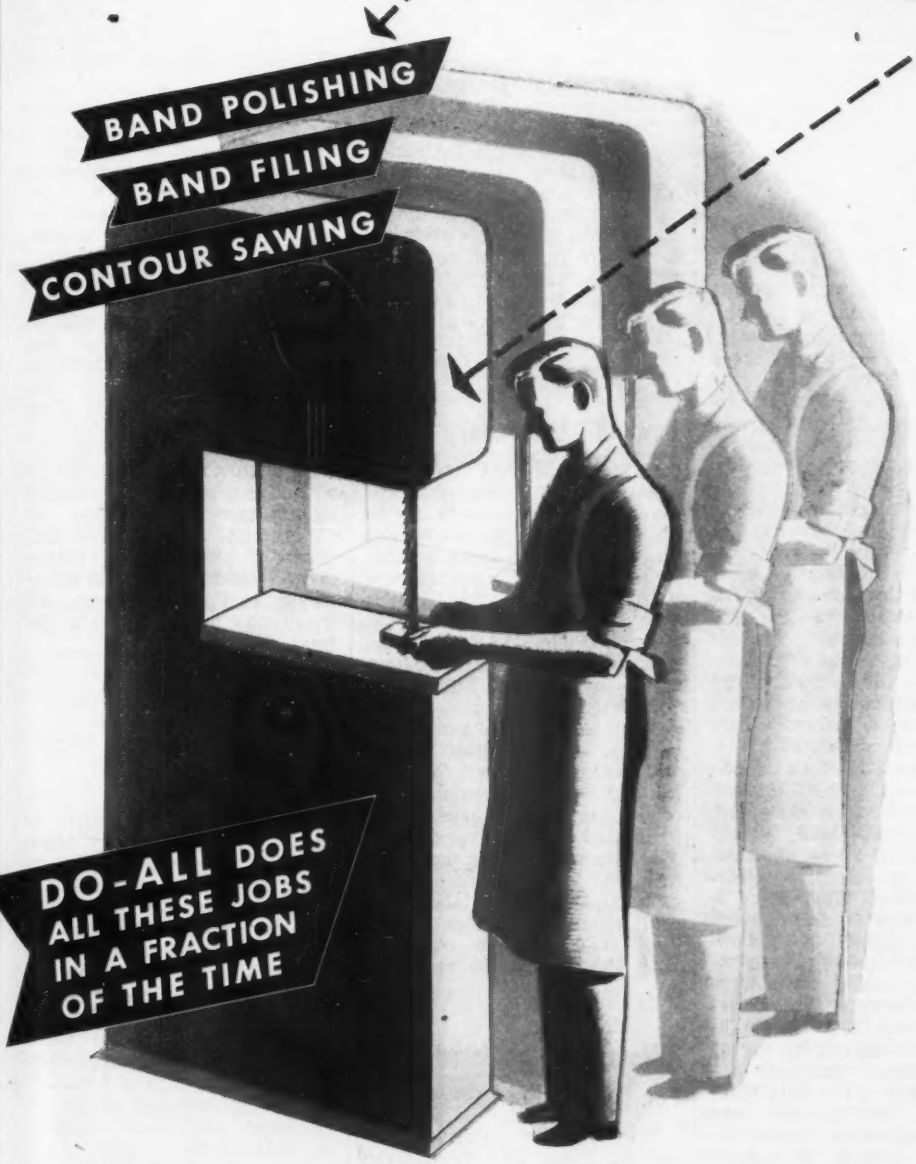
Method of driving engine stud bolts with power has been devised by Fairchild's Ranger Engines Div., which is offering details of the process to other manufacturers. Ranger reports its 21 machines save their cost every 24 days by enabling a worker to drive a day's quota of studs in an hour.

Pre-doped fabric and a high solvency lacquer have been developed by duPont for treating cloth surfaces. Handbrushing is reported replaced by high-speed lacquer spraying; number of coats of dope necessary has been reduced and sanding eliminated.

Chrysler Corp. has announced new process for cementing aluminum alloy and wood and rubber parts.

Conveyors are now being used to carry **rib flaps** through paint baths. Also paints of loud shades, when used on various pieces of shop machinery, are reported to improve workers' morale.

DO-ALL 3 MACHINES IN 1



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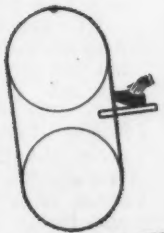

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Aviation Manufacturing

Interchangeability of Parts Still Problem On US Planes, World's Best, SAE Is Told

Los Angeles (Special to AVIATION)—Military aircraft being manufactured by the US aviation industry are better than anyone had any right to expect, but the serious problem of interchangeable parts remains to be solved—and quickly.

That was the message delivered to the Society of Automotive Engineers, Aviation Branch, at its National Aircraft Engineering and Production Meeting, held recently in the Biltmore Hotel here by Maj. Gen. Delmar H. Dunton, deputy director, Air Service Command, Wright Field.

Just returned from a tour of inspection covering all fronts where the AAF is operating, Gen. Dunton reported U. S. military aircraft the finest in the world, but said that keeping them in the fight is being seriously handicapped by variations in supposedly identical parts manufactured by different companies. Assurance that this problem will be solved was given by Pres. Harry W. Woodhead of Consolidated Vultee.

SAE Pres. Mac Short, Vega, called upon Robert Inseley, of the Manley Memorial Committee, to present awards to the 1942 winners, Harry C. Karcher and John Dolza, both of the Allison Division, General Motors Corp., for their co-authored paper on "Correlating Ground and Altitude Performance of Aircraft Engine Oiling Systems."

On the program for the three-day meeting attended by 1,700 were 13 papers, one panel discussion, and the formal speech by Gen. Dunton. Emphasis was on research, with eight papers covering findings in that field. Maintenance occupied a more prominent place than usual, with three papers. Production, heretofore the major problem, was the topic of only three of the papers.

Two controversial subjects, hydraulic vs. electrical controls, and standardized power packs, enlivened two of the sessions, with the former flaring up unexpectedly in one of the earlier discussion periods.

The standardized power "eggs" subject was argued pro and con by a five-man panel. Arguments tended toward the assumption of a "universal" power pack's advantages and disadvantages. In presenting the question, Discussion Chairman C. L. Johnson, Lockheed, listed possible objections to the power egg proposal, and for advantages read quotations from a two-part series of articles in AVIATION Sept. and Oct., '43, by Dr. Sanford Moss, titled "The Case for the Integral Power Plant." RAF Wing Commander McDiarmid clarified misunderstandings regarding British experience with power egg standardization and reported that, on the whole, experience favored the idea. In Britain, he reported, the plan has made it possible to use identical power plants on single-engine fighters and multi-engine bombers without loss of performance efficiency.

The cases for hydraulic and electrical control systems were presented in a paper jointly prepared and presented by W. C. Trautman, Bendix Aviation, Ltd., and R. E. Middleton, Aircraft Accessories Corp. Lt. Col. G. C. Crom, AAF, Wright Field, speaking as an engineer and not as an Army representative, declared that there is no controversy on the subject. Experience gained with both systems on combat planes indicated electrical controls were more satisfactory for a majority of uses. But he qualified that statement by saying that for certain functions hydraulic power is the only feasible form, particularly over short transmission distances. On planes subject to combat damage, he said, hydraulic lines are not favored because damage to them too frequently puts an entire mechanism out of commission. Experience in action has shown that 50 percent of a three-phase electrical wiring system can be put out of action without preventing operation of the equipment. Electric wires, he said, are easier to repair, trouble in them can be traced quicker, and defects or damage can be isolated more easily.

George R. Sanborn, service engineer with Boeing Aircraft Co., said that as a result of present experience with military planes, postwar commercial planes would be designed to require minimum servicing and that maintenance operations could be accomplished in two hours by a six- to eight-man crew.

At Los Angeles SAE meeting (left to right): General Chairman C. L. Johnson, Lockheed; Pres. Mac Short, Vega; Maj. Gen. Delmar H. Dunton, principal speaker; and Consolidated Vultee Pres. Harry Woodhead.

Truman Happier

Conditions he criticized at Curtiss-Wright's Lockland, Ohio, plant have been "largely corrected," Sen. Truman announces. He states he "is very happy to report" that the company "has taken drastic action and recently made real progress. Production is better and expected to become much better."

New AAF Laboratory

Dayton (Special to AVIATION) — Accommodations for planes with wingspans up to 250 ft. and gross loaded weight up to 150 tons—considerably larger than any aircraft now flying—will be provided in the new Static Test laboratory at Wright Field, AAF Materiel Command research center here when the big test building is completed next June.

Equipped with a main test floor area of 170x250 ft., it will contain enlarged facilities for static and dynamic testing of airplane structures under simulated flight conditions. Two wings adjoining the main unit will house testing apparatus and necessary laboratory and engineering-office space. Test floor will be equipped with 150 and 75-ton cranes.

Allowance Considered For Converting to Peace

For months industry has pressed the government to ease up on the renegotiation law, under which Army and Navy Price Adjustment Boards recapture excess profits.

The government has stood firm against all pressure to relax the program or to abolish the law. But in recent hearings, the House Ways and Means Committee took seriously the claims of industry representatives, particularly those of Francis A. Callery and Ralph S. Damon, speaking for the West and East Coast sections of the industry respectively. These men asked that "excess" profits be calculated after taxes, and that aircraft production earnings be considered for the duration of the war, not for just a single year. Otherwise, they said, the industry would lack reserve funds to convert to peace.

Congress is considering provisions under which aircraft and other industries will be justly compensated for the cost of converting their plants back to peace production. This is expected to take the form of liberalized renegotiation and tax benefit terms. Renegotiation is inextricably bound up with the problems of contract termination, liquidation of government owned plants, disposal of surplus war equipment, demobilization of manpower, and other factors. All these may be combined in the final solution.

Douglas Recruiting Chinese, Students

Chinese whose inability to speak English has kept them off the production lines are being enlisted in manufacturing by Douglas Aircraft, Santa Monica, Calif., through a group of sponsors known as China Aircraft, Inc. This organization has already sent a crew of trainees to Douglas to learn sheet metal work. They will become supervisors and instructors in a new factory being financed at an undisclosed California location by Defense Plant Corp.

Chinese will fill all but the top executive jobs in the production of parts for the A-20 *Havoc*. Workers have been recruited by full-page advertisements in San Francisco Chinese-language newspapers. China Aircraft is seeking 400 men and women, but it is not said whether this number will make up the entire staff. The project was worked out at conferences at Wright Field between representatives of the Materiel Command and the Chinese Air Force.

In another move to ease the worker shortage, Douglas' Long Beach plant is recruiting 16- and 17-yr.-old school

students to do simple jobs on *Skytrains* and *Flying Fortresses*. They will work four hours a day at regular pay rates and attend school four hours. School credit will be given for aircraft work.

Terminations Expedited

To get manufacturers whose contract for one item has been terminated to work quickly on a newer product, AAF Materiel Command has adopted a new system to speed procurement procedures and settle details of terminations.

AAF gives no details on how the system will operate, but does say that it "will endeavor to expedite a fair and swift settlement without red tape."

Navy Inaugurates Scheme To Boost Worker Spirit

Washington (AVIATION Bureau—The Navy has established an Aeronautics Section in its Industrial Incentive Division to encourage bosses and workers in plants having prime and sub contracts to manufacture Navy planes. The Incentive Division is headed by Rear Adm. Clark H. Woodward.

The new section will deal with human factors only. It will seek to rouse the fighting spirit of plant workers—including management — to a higher pitch.

Chief among devices to be used will be tracing of origin of planes in combat and sending messages and speakers to the men and women who made them.

This will involve tracking down the serial numbers of wings, engines, and parts by the thousand. A special effort will be made to reach forgotten people in vendor and supplier plants.

Pictures and stories are to be distributed to plant magazines, returned veterans will address plant rallies, reports and booklets will be distributed, war news reported on loud speakers, and combat movies shown—all to bring the war to the home front desk and work bench.

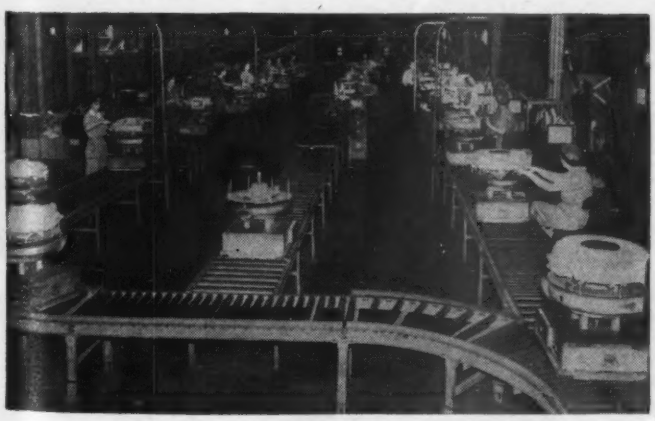
Wider Stock Transfers

Broader list of items which may be transferred from the inventory of one manufacturer to another under authority of the Aircraft Scheduling Unit, Wright Field, has been announced by WPB. List will include swaged cable terminals, certain valves and fittings, flexible conduits, switches and circuit breakers, self-locking nuts, resistors, and certain bearings.

AAF Compresses Year's Testing Into 4-6 Weeks

Dayton (Special to AVIATION)—New model warplanes which the Army used to "feel out" in a year's flying before making large orders are now being put through combat-testing paces in four to six weeks by a group of 50 to 75 pilots of the AAF Accelerated Service Test Branch at Dayton municipal airport.

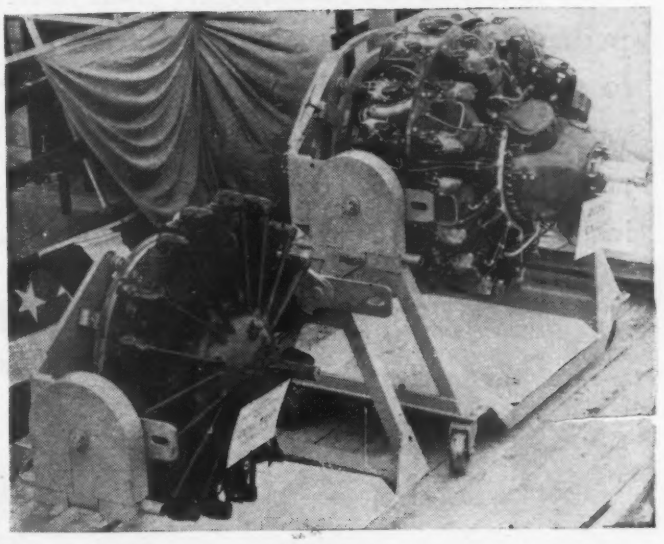
Pilots, a cross-section of combat veterans and youngsters recently graduated, keep their own flight records and make recommendations for changes in planes. Few flyers are assigned to this test flying for more than two months. Flights are made over a small area, even the long distance ones being wide circles about the field in case some difficulty necessitates landing.



ALTITUDE BOOSTERS IN THE MAKING

Turbosuperchargers flow down assembly lines in General Electric's Fort Wayne, Ind., plant and arrive in the foreground ready for inspection. Larger parts are contained on movable racks behind the women workers who take smaller pieces from drawers in wooden boxes on which superchargers roll.

100,000th P&W Engine and 10,000th P-40 Reported Turned Out by Manufacturers



Magnificent then, a midget now. First engine produced by P & W in East Hartford in 1925 (left) was rated at 410 hp. Right: Big 2,000 hp. engine —No. 100,000 from this plant—will soon look small, for company has larger engines in the works.

Since the President called for 50,000 planes a year in May 1940, the price per horsepower has been reduced 30 percent on engines delivered from the East Hartford, Conn., plant of Pratt & Whitney, it was announced by Gen. Mgr. H. Mansfield Horner at a recent ceremony marking the delivery of the 100,000th power plant from this division of United Aircraft Corp. On August's 5,000,000 hp. from this plant the government was thus saved about $20,000,000.

United has also been authorized to purchase additional equipment for a Connecticut plant through a Defense Plant Corp. grant of about $880,000. The resulting over-all commitment by the Government is now approximately $12,350,000.

Production of B-24 P&W engines is at a record high in Buick plants and continues to accelerate, according to Harlow H. Curtice, vice-president of General Motors Corp. and general manager of Buick Motor Division. More engines will be produced in the last quarter of 1943 than during the entire year, 1942; total volume for this year will almost triple 1942 output. Employment in both Flint, Mich., and Melrose Park, Ill., plants is also at an all-time high.

Greater volume and mass production methods have substantially reduced the cost of engines, and the price per horsepower is lowest in aviation history, Curtice said.

The 10,000th P-40 fighter built since July, 1940, has been delivered by Curtiss-Wright to the AAF. Designated P-40N, it is powered by an Allison liquid-cooled engine and carries six .50 cal. machine guns. C-W statisticians figure that P-40's have knocked enemy craft out of the skies in a ratio of from 3 up to 20 to 1.

Other Production Notes

Door-opening 180 ft. wide and 34 ft. high is provided in new Minneapolis hangar completed for Minneapolis-Honeywell Regulator Co. Some indication of possible size of future bombers is said to be imaginable from the fact that 22-ft. clearance has been provided under the mezzanine for propellers, wings, and empennage. The hangar, built at the request of the AAF Materiel Command, will be used for electronic research. It can accommodate five *Flying Fortresses*.

Hangar for servicing its *Corsairs* is being built at Akron for Goodyear Aircraft. Financing of $2,500,000 has been provided by Defense Plant Corp.

Modification of *Liberators* at Fort Worth has been discontinued by Consolidated Vultee so that facilities can be used for increased bomber and transport production. Fort Worth B-24's, nearly 1,000 of which have been modified in the past year, will now be handled at Louisville and Tucson.

Since April Briggs Mfg. Co. production of bomber turrets and heat exchangers has multiplied three times. The company is making parts and subassemblies for seven types of warplanes. . . . Bendix Aviation Corp. output of magnesium castings during August exceeded that in all of 1939, and monthly production, now running nearly 400,000 lb., will soon be almost doubled.

the unseen force that helped conquer the air...

Next to the development of the plane itself perhaps the greatest single contribution to the conquest of the air is the electron vacuum tube. The very heart of radio communications, cross country beacons and instrument landing equipment —*these delicate devices provide the invisible power which enables man to fly safely.* The dependability of air travel is a direct reflection of the dependability and stamina of the vacuum tubes in these services. Eimac tubes are the established leaders in this field. First choice of the major airlines ...first in the new developments in radio...first among the leading electronic engineers throughout the world.

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RAYBESTOS DIVISION (Raybestos-Manhattan, Inc.)
ROCHESTER ROPES
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UNITED AIRCRAFT PRODUCTS

Plumbing Standardized

Manufacture and delivery of metallic aircraft plumbing fittings for making fluid-tight joints will be restricted, after Mar. 1 next year, to AN standard types only by WPB General Limitation order L-313.

Exceptions are granted in direct government purchases, in cases where specific permission has been given, and in maintenance of planes with fittings delivered before next Mar. 1.

Two Pay Rates Raised

The War Labor Board has made two more airframe wage adjustments to curtail labor turnover.

Bell Aircraft plants in Buffalo and Niagara Falls, N. Y., were ordered to establish a starting rate of 65c. and to install a wage structure containing ten labor grades with a minimum rate of 80c. and a maximum of 85c. for the lowest skilled grade and a minimum of $1.40 and maximum of $1.60 for highest grade. The increases average 5c. per hour. The union's request for wage adjustments other than those required by the reclassification program were denied. Bell rates are not applicable to any other industry in the region.

A wage rate schedule recently approved for Boeing in Seattle called for a minimum of 82½c. and a top of $1.60 covering ten grades. At this writing the schedule for Boeing had been approved by the director of Economic Stabilization but the Bell order had not.

Few Accidents

Aircraft manufacturing was among the top five of 31 war industries in worker safety during 1942 and among the top six in the low-accident records, according to the National Safety Council's statistical yearbook. Employees suffered 9.53 disabling accidents per 1,000,000 hr. worked compared with an average of 14.85 for the other 30 industries.

Studies Speed Problems

Dr. George W. Lewis, NACA director of aeronautical research, has recently conferred with several aircraft manufacturers on problems growing out of speeds exceeding 400 mph. In these meetings, he has also reviewed the status of general aeronautical research and development. Engineers and designers of his own as well as other agencies have taken part.

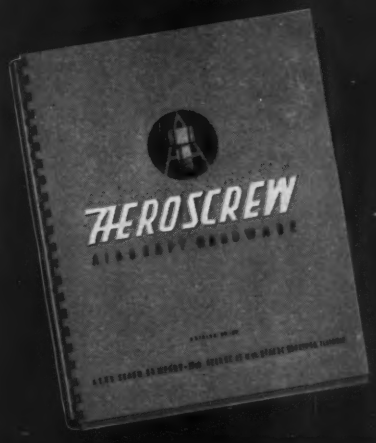
NACA has large laboratories at Langley Field, Va., Moffett Field, Calif., and Cleveland.

Foreign Planes Tested By AAF at Wright Field

Dayton, Ohio (Special to AVIATION) — A British Avro *Lancaster* bomber is the newest addition to the wide variety of foreign planes which are being brought to Wright Field for comparison testing with American types. Other British planes which have been checked here include several Wellingtons, *Spitfires*, and *Hurricanes*, a Boulton-Paul *Defiant* turret fighter, a Bristol *Beaufighter*, three De Havilland *Mosquitos*, and a giant *Horsa* troop glider.

A number of captured enemy planes also have been shipped here. While many were in fragmentary condition, several have been rebuilt into flying form including two models of the Messerschmitt 109. Other craft brought in include a JU-88, a Jap *Aichi* dive bomber, a *Zero*, and parts of several other enemy aircraft. Additional complete planes and parts are being shipped.

WRITE FOR OUR NEW CATALOG...



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Transport Aviation

Roosevelt Approves "Free Air" Principle On Foreign Routes and Reciprocity on Bases

Washington (AVIATION Bureau)—President Roosevelt's comments at a recent press conference on the postwar overseas airlines were the first official guidance that has been presented on that matter. The President spoke because aviation will figure largely in forthcoming agreements between Russia, England, and other United Nations and because the airline industry has felt it was in great need of at least basic information on which to plan.

But the Chief Executive was giving only his opinions. Weighty as these are, at home and abroad, he cannot yet speak conclusively. For one thing, he has agreed with leaders in the Senate to include Congress in any international aviation agreements, many of which come very near being treaties. Furthermore, no conclusions have been reached by the President in his talks with Prime Minister Churchill, though he did say he believed Churchill agreed with him.

Mr. Roosevelt laid down certain working principles which may well be the foundation of the world air system. He said he favored private ownership and operation of all U. S. overseas lines except those to remote places which could not earn a profit—and there will be several. He favored "innocent passage" of airlines—a freedom of the air under which the routes of one country would cross another, permitting fuel stops, under agreement, but not the discharge or pickup of traffic. By using the word airlines he indicated that he was thinking of a number of overseas lines, not just one as advocated by Pan American and United under their "single instrument" policy.

The President disapproved of any attempt by this country to obtain sovereignty over air bases which we have built on the soil of other nations. Common use of these ports should be worked out by agreement among the United Nations, he said.

It was assumed by some members of the Airlines Committee on United States Air Policy that the President had approved their resolution of some weeks ago in favor of "free and open" competition abroad. In effect, the President did approve of the committee's program in general, whether he had it in mind or not. Some highly placed authorities said that Mr. Roosevelt was expounding the conclusions of the Interdepartmental Committee on Foreign Air Policy—whose report had not at this writing been made public.

Soon afterwards, American Export Airlines announced that it favored "regulated competition" on overseas routes, thus joining forces with the Airlines Committee group of 16. Actually, the 16 do not expect that all of them will be in "starvation" competition on the Atlantic or anywhere else. All may apply, but CAB and the President will approve only enough routes to handle the traffic. Not only domestic airlines but also steamship companies and the railroads will be among the applicants. They can come in on a limited basis (supplementing their own services) as the law stands, and they hope to have the law revised (through the Lea bill) so they can compete against existing airlines. Foreign-flag competition terminating in this country can be limited by reciprocal agreements.

CAB Holds Hearings On Feeder Airlines

Washington (AVIATION Bureau) — Civil Aeronautics Board is studying all the data it can find as a basis for certification of routes which will make up the postwar feeder airline system. Initial hearings have been held here.

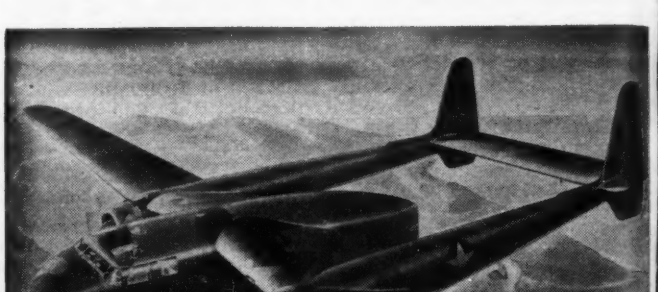
Charles I. Stanton, administrator of CAA, stated his opinion that the shorter distances represent "perhaps the largest chunk of travel business potentially available to our domestic airlines." Assuming that air mail and express traffic would parallel passenger travel, Stanton gave figures from a survey, showing that, if intermediate stops are made between two large cities the travel between them increases enormously.

Short distance travel must have net advantages over other transportation, mainly time and cost. Cost hinges chiefly upon the design of a special short-range airplane. The time advantage depends upon the problem of getting passengers from door-to-door; there is no solution in sight for that one. Stanton was not hopeful for early success of the helicopter for mass work of this kind. If it were possible to build enough airports, located so that door-to-door time would be no more than 15 min., places 100 mi. apart would be within commuting distance. But this problem is not easy.

H. R. Bazley, president of All American Aviation, said that by using the air mail pickup system the government could extend direct air mail to every mail station in the country at small cost to the Post Office and none to the government for airports or aids to flight.

Stanton added that decreasing costs of airline operation will facilitate flying all first class mail where delivery will be expedited. Surface transport of mail now costs the Post Office .14 mills per pound-mile; air is .96 mills. He said the eventual rate for all first class mail by air, to be paid carriers, might be .4 mills per pound-mile.

He reported that only 52 of the 122 cities from 25,000 to 50,000 population outside metropolitan districts and only 58 of the 413 such cities from 10,000 to 25,000 now have direct air service and that most of them ought to have it.



FAIRCHILD FOR WAR AND PEACE

Fairchild cargo carrier designed for carrying warriors and material is also expected to be suitable for peacetime hauling. Specifications are now restricted to the facts that the plane is metal, built to operate from medium-sized fields, and has "a range in excess of 3,500 mi."

Seaboard Case Results In "Air Monroe Doctrine"

Washington (AVIATION Bureau)—The famous Atlantic "seaboard" case—which indicates a Monroe Doctrine for aviation—needs a little explanation for the record. CAB had consolidated a number of Atlantic coast route applications for economy of hearing time. Among them was the Colonial application for a line from New York to Nassau, Bahamas, which came under the head of "foreign" business.

Because the board is not considering any foreign applications—awaiting the determination of U. S. foreign air policy—CAB shelved the whole group and so advised the President. Mr. Roosevelt returned the decision with neither approval nor disapproval, because it was not really a decision but a postponement.

At the same time, the board announced that it was returning to active status all applications for routes to Mexico and the Caribbean which connected with South America—and in fact, inviting new applications. This is significant on two counts: First, it reestablishes the Miami-Caribbean route invitations of a year ago. At that time the Miami expansion was a military proposal to serve the Caribbean because shipping was so short. It was abandoned because Army and Navy disagreed on it. Now it's a good neighbor proposition. Second, CAB's consideration of such routes indicates they are not regarded as foreign.

In other words, other countries will not be consulted about what we do in the Western hemisphere.

Foreign Airmail Needs

Total volume of US mail to foreign countries now sent by sea is about 70,000,000 lb. an-

nually, according to a survey by Civil Aeronautics Board. From 142 to 231 transport planes could handle all overseas mail, assuming daily schedules, and carry many passengers and cargo, in the opinion of CAB analysts.

Since postal rates for seaborne mail are very low, the amount sent by air would depend upon downward adjustment of airmail rates. Probably all US foreign mail would never be carried exclusively by air. However, the government could transfer all outbound mail to planes. Such action would result in great development of international services.

Cities Taking "Paper and Concrete" Steps To Become Postwar Transport Centers

Major cities are announcing plans for postwar air transport. In New York, where the Mayor and City Council periodically argue over the suitability of Idlewild as the name for the huge airport already being built several miles from LaGuardia Field on the south shore of Long Island, the Board of Trade has established an Aviation Section. It is intended, says Floyd N. Dull, Board of Trade president, to "serve as the representative spokesman for the growing aviation industry in this area and will offer a clearing place for ideas and platform for an aviation forum."

In Oklahoma City, engineers of the Austin Co., contractors, have submitted plans for a $25,000,000 locally-financed passenger and freight terminal covering six square mi. of land and 2,500 acres of water for seaplanes. Two of six runways will be 11,000 ft. long and 500 ft. wide, a size thought suitable for glider tow trains and planes carrying 400 passengers or 160,000 lb. of freight. Railroad and truck freight will be discharged on a level below the loading ramp; transfers will be made by elevators. A 100-room hotel and helicopter facilities have also been planned.

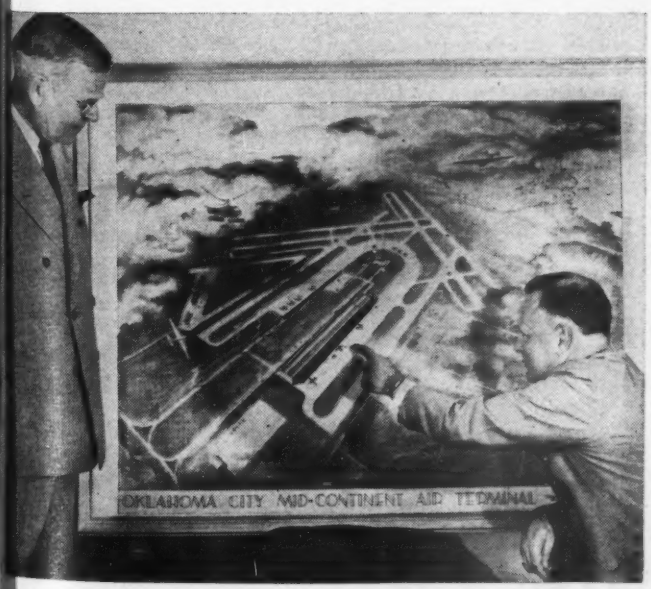
In Nashville, where a 7,000-ft. runway and 5,300-ft. landing strip are being completed in a $2,000,000 expansion program at Berry Field, plans have been announced for eventual development of the municipal airport. Contemplated are four 10,000-ft. runways and other facilities for handling 35 planes simultaneously.

Other large postwar projects are being planned by Miami, Memphis, and Atlanta.

Another Month— More Applications

Washington (AVIATION Bureau)—It would take pages of fine print to tell about all the applications for new air routes, domestic and foreign. Although CAB has stated that the date of filing will have no bearing on the ultimate decision, applications continue to pour in. No new operations can begin unless the Army and Navy approve of them as military necessities and allocate airplanes to them.

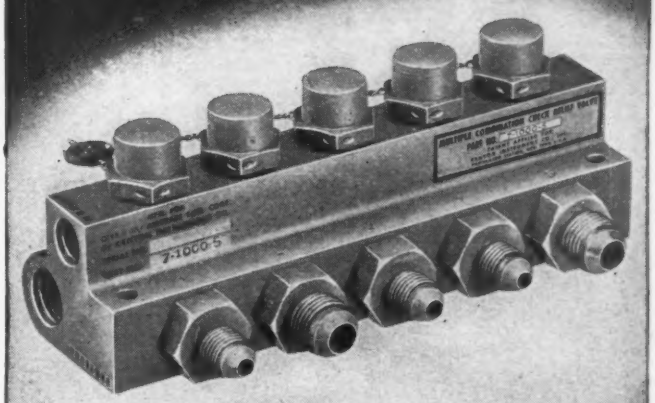
Only 27 of the approximately 150 airplanes requisitioned from the airlines by the Army have been returned.



L. D. Engle, Austin Co. engineer (right), shows Mayor R. A. Hefner of Oklahoma City, the location of one of two 11,000-ft. runways planned for the city's projected $25,000,000 airport.

The boys just naturally called it the

"PICCOLO" VALVE



It started out as the Kenyon Combination Multiple Check-Relief Valve Assembly—but the boys who worked on it had a better idea.

So now it's the Kenyon "Piccolo" Valve.

More important than the name is the fact that it provides in a single housing a multiplicity of valve units (as many as 16), all of which discharge into a common return line. Used in the high-pressure hydraulic valve systems of military or commercial aircraft, the "Piccolo" Valve

★ centralizes the thermal expansion relief valves of several closed hydraulic systems.

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Full construction details and specifications of the "Piccolo" Valve supplied on request. We also solicit inquiries on all types of precision aircraft instruments.

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Aviation Abroad

New Jap Planes

Several new types of Nipponese warplanes are reported in Jap army announcements. These planes, supposed to make America and Britain "shiver in their boots," are the *Shoki* fighter, *Shitei* patrol bomber, and *Donryu* heavy bomber. Around Wewak and China, a new Jap fighter has been encountered which looks like a German design or at least a copy of Nazi ideas. It has a V-type in-line engine and more armor than is usual in Jap types. Its armament remains the same as on the *Zero*, consisting of two 7.7 mm. machine guns in the wings and two 12.7 mm. small cannon firing through the airscrew arc. Both span and length are approximately the same as in the *Zero*.

A few planes of this new model have been shot down by our P-38's, for which they are reported to be no match.

Malta Was BOAC Stop Even at Peak of Bombing

Even during the peak of Axis bombings against **Malta**, regular flights of the British Overseas Airways were being "checked out of" Malta, employed as an intermediate base for the BOAC England-Egypt route.

Services which are now being operated by the corporation cover a great part of the world, the main ones being as follows: Britain-America via Lisbon and Bermuda, also flown via Lagos across South Atlantic; Britain-Foynes (Ireland) and Britain-Lisbon; Britain-Canada nonstop with landplanes.

In the Middle and Far Eastern areas: Cairo-Karachi, Teheran, and Habaniyeh, Khartoum-Lagos, Nairobi and Asmara, with connections from Asmara to Cairo and Addis Ababa, and also to Karachi.

New services have also been operated for some time between Kisumu and Madagascar. The above services, however, do not give a complete picture of BOAC's operations, since mention of some routes is still restricted.

★INTERNATIONAL BRIEFS★

F. C. Sturroch, minister of Transport for South Africa, recently announced that a South African airline would establish service to England right after the end of the war bringing resumption of normal air connections.

British Overseas Airways' last deHavilland *Albatross* plane, one named the *Fortuna*, recently cracked up during an emergency landing near Foynes, Ireland. While the plane was a total washout, no passengers or members of the crew were injured.

NAZIS STRAIN TO FIX EDER

Vital importance of Eder dam to German war effort is evidenced by Nazis drastic efforts to repair it—clearly shown in this reconnaissance shot taken two months after RAF Lancasters blasted it open to flood countryside. The dam reservoir is now completely dry, and the river's waters are being drained through No. 2 power house (seen at A just left of dam breach). Construction of light railroad B indicates preparations for repair. And camp accommodations for workmen have been set up at C. It means a diversion of mighty-scarce labor from other war work. (International News photo.)

On Schedule . . . by "Vista"

One of Sweden's ABA transports has been lost on its flight from a Scottish base to Stockholm, Sweden—first such blow suffered by the line since its launching in Mar. 1942. This service, only neutral airline from continental Europe to England, was started when Sweden felt it needed closer and faster contact with Britain, and it has been operated with outstanding regularity. At this writing, it is not known how the line's plane went down; its radio suddenly became silent, and no trace of wreckage or survivors has been found. Among those on board was Capt. K. G. Lindner, chief pilot for ABA and one of Europe's outstanding transport flyers.

Spain, having recently purchased the Nazi-controlled Iberia airline, is now negotiating with both Britain and America to obtain gas, spare parts and, if possible, new aircraft, to maintain connections with Portugal, Spanish Morocco, and other Mediterranean points.

In England, where the rather one-sided interest of the government re air transport has aroused criticism, the Empire Air Parley opened on Oct. 11. With Lord Beaverbrook as chairman, the agenda called for a unified plan for postwar air cooperation between the Dominions. This parley is expected to indicate the attitude which the British Empire will take at United Nations' air conferences which will undoubtedly follow. Incidentally, it is said that Lord Beaverbrook was brought back into the government as Lord Privy Seal specifically to consider postwar civil aviation matters.

The RAF and other British air forces are flying a complete set of captured German and Italian planes for identification and for practice-flight instruction of new crews. Especially during the recent African and Sicilian campaigns, many undamaged examples of the latest German planes were found.

To instill confidence in new crews, British *Halifaxes* **are** flown regularly on any one of their four engines. The plane is said to be able to maintain altitude with sufficient gas on board to bring it back from all normal missions.

A recent article mentioned the mistaken attitude of the public that military planes are cheaper than is generally announced. While a first class fighter in America will cost from $125,000 ot $150,000 and a *Fortress* about $450,000, a *Spitfire* cost the equivalent of $20,000 little more than a year ago, and a *Stirling* bomber about $120,000. Lower operating costs and wages, different manufacturing processes, and higher production are generally given as the main reasons for this price differential.

Latest German long-range fighter is the Me-410, a development of the Messerschmitt 110 and 210. While no specific details on this new model have yet been made available, it is known that the Me-210A, with its half-ton of armor plate, had serious structural defects. They probably have been corrected in this latest version.

According to the Nazis, current high tonnage bombing against war industries in Germany and its satellites is only an Allied move to promote postwar American and British exports to the continent. Similar bombing tactics by the Nazis were, naturally, only attempts to obtain sufficient lebensraum.

Three big British shipping concerns, Cunard, Furness, and Manchester Lines have now amended their charters to allow them to purchase or charter airliners to operate postwar airlines. Cunard especially has been interested in air transport, and at one time or another had some interests in both Imperial Airways and its successor, British Overseas Airways.

United Airlines has received permission from the CAB to purchase 3,750 out of the 5,000 shares of stock of the Lineas Aereas Mineras S. A. in Mexico, with the stipulation that operations would not be extended beyond Mexico's borders.

British aircraft production has reached such proportions that there is an actual shortage of test pilots for the acceptance of new aircraft. Some pilots are now being transferred from operating squadrons to special schools which will train them for their exacting duties at the big aircraft plants.

Harold J. Riog, president of Pan American Grace Airways, has received Bolivia's highest decoration, *Condor de los Andes*, in recognition of his outstanding services to that country.

TACA (Transportes Aereos Centro-Americanos) very soon will **open a regular airline** service between San Jose, Costa Rica, and Miami, Fla., realizing one of the dreams of its founder and president, Lowell Yerex. BWIA (British West Indian Airways)—another Yerex venture—is already flying from Trinidad to the United States.

Air Commodore A. H. Orlebar, 46, has died in London following an illness of several weeks. Celebrated as leader of Britain's Schneider Cup racing teams in '29 and '31, Orlebar most recently was with Combined Operations—the RAF Commandos—as acting air vice marshal, then as deputy chief.

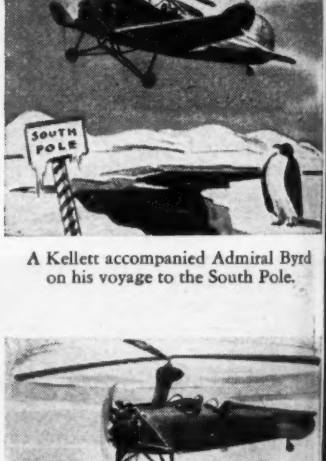
The Eastern Air Lines KELLETT which flew mail for a full year from the roof of the Philadelphia Post Office. One of many Kellett "firsts" in its years of pioneering the manufacture of rotary wing aircraft.

THE PIONEER LOOKS TO TOMORROW

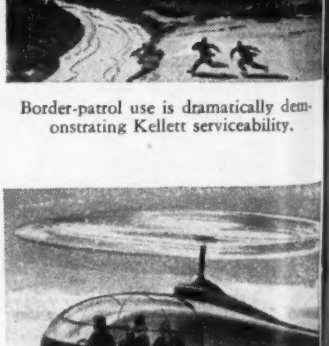
TODAY in cooperation with the U.S.A.A.F. Kellett is speeding the engineering development and production of autogiros and helicopters for military needs. We cannot give details now. Five Kellett plants are also applying their aeronautical ingenuity to the production of important parts for some of America's most famous fighters and bombers — Thunderbolts, Liberators, Warhawks and Marauders . . . while an expanding corps of forward-looking engineers continues Kellett's rotary wing developments for the future.

TOMORROW we look forward to opportunities for Kelletts to cut time and costs in patrolling electric power lines, oil pipe lines, in transporting mail and passengers, dusting crops—and in a wide variety of services for industry, commerce, forestry and agriculture. Kellett's years of experience and accomplishments continue to attract pioneering minds, men who, with us, see vast opportunities for rotary wing progress in the post-war era. Kellett Aircraft Corporation, Upper Darby (Philadelphia), Pennsylvania.

A Kellett accompanied Admiral Byrd on his voyage to the South Pole.



Border-patrol use is dramatically demonstrating Kellett serviceability.



. . . and Kellett is looking to a future of expanding service to the nation.

KELLETT

OLDEST ROTARY WING AIRCRAFT MANUFACTURING COMPANY

Aviation Finance

Chicago & Southern Air Lines has registered 107,989 common shares with the SEC to provide funds for expansion of facilities and reduction of loans. Of the shares registered, 60,000 are to be offered to underwriters at a maximum price not exceeding $16 a share or $960,000, while 47,989 shares are registered to be issued pursuant to options at $8 a share or $388,912.

United Air Lines is prepared to spend as much as $20,000,000 in postwar expansion in the first 18 mo. after the fighting ends, according to Pres. W. A. Patterson. At the same time, however, Mr. Patterson warned that care was necessary to avert danger of overexpansion and ill-advised financing by the aviation transport industry in the postwar era. Meanwhile, UAL has received CAB approval of its purchase of controlling interest in the capital stock of Lineas Aereas Mineras, S. A., of Mexico. Price was $146,750. The board stipulated that United's operation of the line must not go beyond the borders of Mexico.

Aviation Corp. reports net earnings for the nine months ended Aug. 31 of $2,810,486 or 49c. a share against $3,671,716 or 64c. a share in the like 1942 period. Sales were $57,234,554 compared with $29,635,211 the previous year. Postwar adjustment reserves of $855,000 were set aside against $495,000 for this purpose last year. This report, drafted prior to 1943 renegotiation, does not include equity in undistributed earnings of a number of subsidiaries which are not consolidated or of companies in which large investments are held.

Bendix Aviation Corp. sales of $643,000,000 for the nine months ended June 30 were at an annual rate almost 50 times those of all of 1938, Pres. E. R. Breech revealed in a letter to stockholders. Sales in the like 1942 period were $297,000,000. Price reductions of $149,000,000 were made in the first nine months of the 1942 fiscal year.

Beech Aircraft has developed a sideline far removed from its plane-making activities. The company is drilling for oil with one well reported to be down 3,210 feet under its Wichita airport. Another well has been started seven miles south of its plant.

Northeast Airlines will undertake new financing of $1,800,000 to $2,000,000 if its application for a Boston-New York route extension is approved, according to company officials. A decision on the application is not anticipated before next spring or summer.

Ryan Aeronautical Co. is increasing its board of directors from three to five members through the addition of Frank N. Phillips, president of Washburn Wire Co. of Phillipsdale, R. I., and C. Arnholt Smith, vice-president of United States National Bank of San Diego, Calif. Ryan also reports net earnings for the eight months ended June 30 of $424,648 or 97c. a share. Pres. T. Claude Ryan warned shareholders that the figures should not be considered "definite or final" because profits for the period are still subject to renegotiation.

Air Associates has declared an extra dividend of 35c. a share in addition to the regular quarterly dividend of 20c. a share on the company's common stock.

Year-end dividend payments by a large number of aircraft concerns probably will be made this month. Notice of payments will be made earlier this year to aid the taxpayer in making his final income tax estimate on Dec. 15.

All-American Aviation reports unfilled orders amounting to about $3,000,000 and recently stated that profits for the September quarter were more than sufficient to cover the annual dividend requirements on the recently offered convertible preferred stock. Current assets on Aug. 31 were more than double current liabilities.

W. R. Grace & Co., owner of one-half the capital stock of the Panagra Air Line, also has been the second or third largest owner of Eastern Air Lines' stock. This was revealed at a recent CAB hearing held to act on Panagra's application to secure a United States terminal for its line now operating along the West coast of South America.

Curtiss-Wright Corp. has received notice of conclusion of renegotiation on its 1942 earnings. The final settlement was the same as indicated in the preliminary report, which showed that voluntary price reductions plus renegotiation would result in a saving of $175,139,379 to the government on the company's 1942 business.

Aircraft Accessories Corp. reports net earnings of $741,433 or $1.21 a share for the fiscal year ended Apr. 30, against $265,662 or 44c. a share in the preceding fiscal year. On the basis of the increased common stock outstanding on July 30, as a result of preferred stock conversion, the earnings for the year ended last April would amount to $1.04 a share.

Sellers predominated in July stock transactions in aviation stocks on the part of officers and directors, according to the SEC. Tabulation: Republic Aviation Corp., 3,900 shares purchased by John J. Daly, a director; Aviation Corp., 1,680 shares sold by Victor Emanuel, president, and 1,500 shares sold by William F. Wise, vice-president; Continental Motors, 1,000 shares sold by Thomas Jackson, an officer; and Western Air Lines, 2,900 shares sold by Wm. A. Coulter, a director.

Sperry Corp. reports net earnings of $4,242,813 or $2.11 a share for the first half of 1943 compared with $2,394,237 or $1.19 a share in the like 1942 period. An additional reserve of $2,500,000 has been set aside from earnings to meet contract terminations.

By RAYMOND L. HOADLEY

Trickle of profits in '44 . . . . Prospects for modifications in "reneg" . . . . Rail-air issue brews . . . . Airline stocks.

AIRCRAFT STOCKHOLDERS can, in the case of most companies, look forward to substantially increased sales again next year, and they are also entitled to hope that a small trickle of additional earnings may be reported in 1944. Still, the latter can be only a slender hope, for there can be no assurances of larger aircraft company earnings even though the 40 percent increase in warplane production planned by the WPB in 1944 is achieved. The Treasury wants a 10 percent jump in normal corporate taxes next year—to 50 percent. That, if enacted by Congress, will hurt. And although a wide assortment of bills have been dropped in the legislative hopper, Congress so far gives little indication of giving the aircraft industry any tangible relief from its present intolerable financial position.

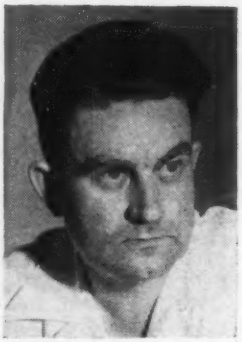
No measureable progress has been made in the last six months in straightening out the confused situation surrounding contract termination, and no substantial relief seems in sight in connection with the current harsh renegotiation procedure. Protracted hearings held by two House committees have indicated the plight of aircraft concerns with respect to working capital and postwar reserves, the case being capably presented by representatives of the industry. But most members of the powerful Ways and Means Committee still seem determined to continue contract renegotiation with but minor modifications.

Such modifications, it appears likely, will include (1) the right of appeal to the courts when contractors feel they have been treated unfairly, (2) full plant amortization in figuring war production costs, and (3) exemption of firms having less than $500,000 of war business in one year. Anxiously awaited will be the more major decision by our lawmakers whether to effect renegotiation *before* taxes or *after* taxes. Most administration officials strongly oppose the latter alternative, but in such possible action by Congress lies the only substantial aid in this highly controversial matter that appears in the offing for the aircraft industry.

Meanwhile there is much initerest among the airlines regarding the battle the railroads have quietly waged to permit their entry into the air transport field. The Association of American Railroads is behind the move to reverse a tradition of law and government policy dating back to 1914. The issue probably will be fought out in Congress this winter, with the airlines bound to oppose, tooth and nail, the attempt by the rails to break into the air transport field.

Airline stocks have dropped back from their high prices established earlier this year, with Wall Street offering various and sundry reasons for the decline. Most plausible explanation to us is the fact that these stocks have advanced much faster than the rest of the stock market—so much so that an adjustment was long over due. Airline prospects are as promising as ever, but the continued high ratio of their stock prices to earnings indicates that future prospects of this popular group have been fairly well discounted for the time being. Furthermore the excess profits tax has placed a definite ceiling on the earning power these stocks can establish in wartime.

Aviation People

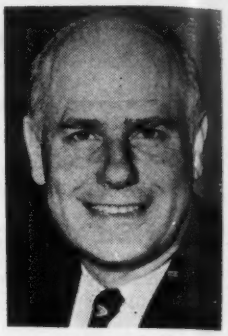


FELIX KALLIS, for the past six months chief engineer of Southwest Airways, has been appointed general manager of the company's aircraft and engine overhaul depot on Thunderbird Field. He will continue as chief aeronautical engineer in addition to his new managerial duties. (Southwest Airways photo.)

MRS. ALLAIRE C. duPONT, widow of Richard C. duPont, was elected a director of All American Aviation, the company founded by her husband. Mr. duPont had severed all relations with the company when he became special assistant to the Commanding General in charge of the Glider program.

J. I. HAMILTON, former administrative engineer of the propeller division of Curtiss-Wright, has been named assistant to R. Elmer Minton, manager of military programs for the division. His new work will include coordinating Curtiss electric propeller output meeting warplane manufacturers schedules.

PAUL J. STURM has been appointed manager at Sky Harbor, Southwest Airways' war training service school. He has been general manager of the company's overhaul depot, operated for the AAF. His first task will be extensive improvements in the shop and hangars. (Southwest Airways photo.)

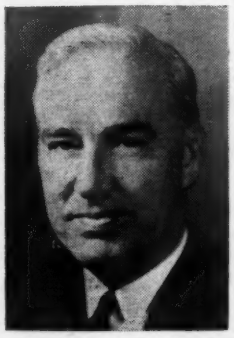


ROBERT H. HINCKLEY, asst. to the president of Sperry Gyroscope, was honored by Ogden, Utah, which has named its new $900,000 air terminal the Robert H. Hinckley Airport in recognition of his contribution to the development of civilian and commercial flying and airports throughout the nation.

LT. COL. BEN STERN has been appointed director of information and statistics for the Civil Aeronautics Administration. While on active duty with the Marine Corps he was detailed to the Coordinator of Information and to the OWI as special field representative. (CAA photo.)

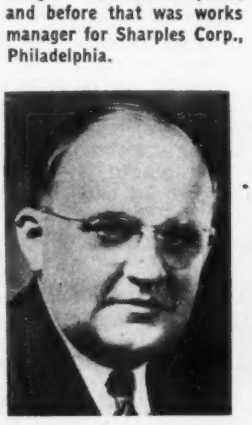
JOHN J. BUCKLEY has been appointed production manager of Hub Industries, Inc. He was formerly on the staff of Anderson Nichols Associates, consulting engineers for Curtiss-Wright's Columbus plant, and before that was works manager for Sharples Corp., Philadelphia.

CAPT. STAN A. PALMER, member of the first Army P-40 fighter squadron sent to the defense of Guadalcanal and a veteran of the South Pacific war theater with more than 75 combat missions to his credit, is now asst. operations officer and test pilot checking P-40's for the Army.



BERNARD L. WHELAN has been elected general manager of Sikorsky Aircraft division of United Aircraft. He has been with the company for 15 yr.; started as a test pilot in 1928, became manager of Rentschler Field (then known as United Airport), and later became general manager of the United Airport division of the corporation. United also announces that **LORENZO L. SNOW** (right) has been made manager of the airport division. He, too, is a veteran pilot who received his first flight instruction from Arch Hoxie in 1911. Before joining Pratt & Whitney as an installation engineer in 1934 he operated an airport.

ROBERT McCULLOCH resigned from McCulloch Engineering Corp. to undertake a new development vital to the war effort. His newly formed organization will be known as the McCulloch Aircraft Co. He announced, however, that he will remain as a member of the board of directors and will serve as consultant to the Engineering Corp., which will continue to operate as a self-contained unit with the same personnel at its present site under the management of **R. J. MINSHALL** (right) who has been named president.



CAPT. WILLIAM A. WINSTON, Pan American Airways pilot, has completed ten years of flying for the company. Using his 17th logbook, he has 14,000 hr. of flying to his credit and has commanded PAA Boeing "Clippers" since 1939. (PAA photo.)

T. C. DOUGAN has been appointed assistant general purchasing agent for United Air Lines at Chicago. He has been with the company's purchasing department for the past five years as buyer and, since the war, as priorities specialist. (UAL photo.)

MAJ. GENERAL WALTER R. WEAVER, recently commanding general of the US AAF TTC, has become associated with The Aviation Corp. and will serve in a consultative capacity. He will retire from the service after more than 40 yr. of Army life.

Recent Books

• *BOOT STRAPS: THE AUTOBIOGRAPHY OF TOM M. GIRDLER in collaboration with Boyden Sparkes. Charles Scribner's Sons, New York.* 471 *pages,* $3.

Shortly after his adventure over Tokyo, Gen. Doolittle visited a Consolidated Aircraft Corp. plant in California. And when Chairman Tom Girdler showed him "our full-size model of the biggest airplane that has ever been conceived," Doolittle leaned back to see the whole of this structure and said: "I don't believe it. It's just a damned lie."

This bit is among the highlights in Girdler's account of his career. As he tells it here most of his efforts have been directed toward the perpetuation of the type of management which, stimulated by the profit motive, has resulted in the present development of American industry. Girdler describes himself as a specialist in management rather than one in any particular field of enterprise. Thus after years in steel, culminating in the chairmanship of Republic Steel Corp., he was able to assume the additional duties of the chairmanship of Consolidated Vultee. Of this position he writes at some length of his company associations, particularly with Pres. Harry Woodhead and Designer I. M. Laddon.

He also issues a sober warning to his readers: "Inevitably the people of the United States are going to have to make up their minds whether they want to gamble their lives and happiness on some socialistic scheme of state capitalism, entirely theoretical, or whether as free individuals to drive ahead to achieve a still higher living standard out of various enterprises growing out of capitalism."

• *MATHEMATICS OF FLIGHT, by James Naidich. McGraw-Hill Book Co., New York.* 400 *pages, illustrations, index,* $2.75.

• *MATHEMATICS FOR THE SHEET METAL WORKER, by Clayton E. Buell. Pitman Publishing Corp., New York.* 199 *pages, index,* $2.

• *SHOP MATHEMATICS, by Arthur A. Dick. Ronald Press Co., New York,* 230 *pages, index,* $2.40.

Naidich: From arithmetic through equations, ratios, scales, proportions, angles, and simple trigonometry to the principles of aerodynamics and research which are outlined in problems. A brief directory lists construction features and specifications of American civilian and warplanes. Designed to prepare students with no previous mathematics background for aviation training.

Buell: Practical topics simply considered for shop workers include use of formulas; bend allowances; measurement of lengths, areas, weights, and volume; template development from tables; and strength of materials.

Dick: Fundamentals of arithmetic, algebraic equations, geometrical constructions and computations, and practical trigonometry for vocational school curriculums.

• *GAS TURBINES AND JET PROPULSION FOR AIRCRAFT, by G. Geoffrey Smith. Flight Publishing Co., Ltd., London. Paper bound,* 80 *pages, illustrations,* 75c.

"Air is the working fluid," writes Managing Editor Smith (of British magazines *Flight* and *Aircraft Production*) of this power system. "Fuel, which for practical purposes will be any of the natural or synthetic hydrocarbons which we use in engines today, is required for addition of heat to the air. Air is drawn in, compressed into a heating chamber, and heat is added by the combustion of fuel. On re-expansion sufficient energy is taken by a motive unit to drive the compressor, and the air, still capable of expansion, discharges to atmosphere as a high-velocity efflux from a nozzle or nozzles.

"This efflux, or jet, produces a reaction, in the nature of an axial thrust on the plant, which constitutes the propulsive effort. . . . By comparison with a supercharged four-stroke reciprocating engine, a turbine-compressor plant should materially reduce cost, weight, production time, and complication."

Principles, design, and construction which may result in these advantages are assessed by Smith in chapters on compressors, effect of the system on aircraft design, and steam and gas turbines.

• *METALS AND ALLOYS DATA BOOK, by Samuel L. Hoyt. Reinhold Publishing Co., New York.* 334 *pages, charts, index,* $4.75.

Confining himself solely to figures—and what little prose is necessary to clarify them—Mr. Hoyt, technical advisor to the Battelle Memorial Institute, has compiled 340 tables on the properties and characteristics of various metals and alloys classified as wrought, cast, and stainless steels; heat- and corrosion-resistant casting alloys; non-ferrous alloys; and additional metals including chromium, cobalt, tungsten, cadmium, and bismuth. Other tables of general data include the periodic system, properties and melting points of elements, simple tests for identifying metals, and conversion and specification information. The material is intended for engineering application, not instruction.

• *AIRCRAFT ELECTRICAL ENGINEERING, by Randolph Matson. McGraw-Hill Book Co., New York.* 372 *pages, illustrations, index,* $3.50.

This is a clearly written text which, to quote the author, assumes "a reasonable acquaintance with electrical theory." But "the vast amount of theory and technical data that is necessry in the design of electrical apparatus for aircraft has been omitted, because these design problems are encountered primarily by equipment manufacturers."

Result is an easily understood introduction to the principles, operation, and installation of modern equipment. Material is listed under the headings of drawing practice, wiring, power supply systems and equipment, motors and power drives, lighting, conduit, junction boxes, bonding and shielding, and radio.

• *STUDIES IN ARC WELDING. James F. Lincoln Arc Welding Foundation, Cleveland.* 1,295 *pages, illustrations, index,* $1.50.

A section of seven papers, included in this collection of 98 covering general industrial fabrication, is devoted to aircraft. With illustrations, drawings, specifications, and calculations of costs, these articles consider economical welding of engine mounts, design of a welded propeller blade, redesign of engine tail pipe to increase length of life, arc welding of magnesium structures, boilers, and tubular fuselages, and determination of what parts should be arc welded.

• *SPIN IN, DUMBWHACKS, by Lt. Richard N. Ryan, AAF. J. B. Lippincott Co., Philadelphia.* 153 *pages,* $1.75.

Humorous, breezy account of the author's experiences from physical examination to wings—all of which impressed him with the injustice of the fact that "birds is lucky. They learn easy-like."

Canada Trains Them By Tens of Thousands

(*Continued from page* 221)

the elementary training aircraft; and (3) Total costs of the plan excluding (1) and (2) were to be borne by Canada, with 80.64 percent; Australia, 11.28 percent; and New Zealand, 8.08 percent.

Subsequent to these arrangements and owing to the exigencies of war, the United Kingdom was unable to provide all the aircraft and parts called for. Canada, as agent for the United Kingdom, then purchased necessary equipment to a total of $98,000,000, largely from the United States.

In the latter part of 1941 certain RAF schools were established in Canada, the entire cost of which, except land, was to be borne by the United Kingdom. A new agreement was entered into June 5, 1942, to extend activities of the training plan to Mar. 31, 1945.

On June 30, 1942, the financial situation under the old agreement was substantially as follows: Total expenditures under the plan, excluding contributions in kind by the United Kingdom, were $500,567,000, of which $43,000,000 was payable by Australia and $35,000,000 by New Zealand. Total monetary obligation of the U. K. under this arrangement on July 1, 1942, was approximately $279,000,000, of which $66,500,000 has been received and the balance is presently being examined by both governments for final settlement. The value of contributions in kind from the U. K. to that date probably exceeds $100,000,000.

The present agreement calls for maintaining all RCAF and RAF schools in existence on June 30, 1942, and institution of additional schools, particularly the more advanced training units. The entire cost of training in Canada of RAF, RCAF, RAAF and RNZAF aircrews, including recruiting, manning, and elementary training of RCAF aircrews previously borne exclusively by Canada and operational training previously borne exclusively by the United Kingdom was estimated to cost $1,446,000,000 from July 1, 1942 to Mar. 31, 1945. The agreement called for the United Kingdom to assume a liability for half this amount, $723,000,000.

The governments of Australia and New Zealand will pay for training their personnel in Canada on a per capita basis as arranged between the governments of United Kingdom, Australia, and New Zealand. The amounts received for such training will be credited to the U. K. against her liability to Canada.

Under the present agreement lasting to Mar. 31, 1945, Canada is supplying a substantial proportion of the trainees but not the proportion she supplied under the old agreement because of the larger total, and numbers of trainees sent by U. K. is increased. This includes men from other parts of the Empire and from European members of the United Nations. Complete coordination of air training has been established, with the RAF schools preserving identity but integrated under RCAF control. Canada, as administrator of the plan, determines the nature and quantities of equipment required.

"Quality rather than quantity has become the keynote of the training organization," Minister Power emphasized. "As a more experienced training organization emerges, so the caliber of training improves.

"The first great rush to get people overseas in a hurry is about over," he added. "Subsequent developments have been directed more toward improving the quality of training than increasing the number of air crews graduating. The ever-changing methods of modern warfare require continual revision of training methods and teaching of additional subjects. To meet this condition, greater emphasis is being laid on specialist training in navigation, armament, and instrument flying. Some new schools

The Guardsman Way Speeds Up Production of CG-4A Gliders

Guardsman AVIATION FINISHES

Proved by tests with 5 Manufacturers

— Operations cut from thirteen to seven

— Man-hours of labor cut from 24 hours, 56 minutes — to 8 hours, 32 minutes

— Elapsed time for finish cut from 29 hours, 48 minutes — to 2 hours, 32 minutes

— Materials consumed cut from 29½ gallons — to 14 gallons

These savings in time, man-hours, operations and materials can not be overlooked in the urgency of war production — when every second counts — when every minute saved in production means more needed equipment on the fighting fronts. These production tests made over a period of 90 days with 5 different manufacturers* of CG-4A Gliders confirm the vital job Guardsman Aviation Finishes can do to speed up production.

*Name of manufacturer on request.

What GUARDSMAN AVIATION FINISHES are doing for others, they can do for you.

Continuously supplying finishes to Wright Field since 1935.

GRAND RAPIDS VARNISH CORPORATION

GRAND RAPIDS · MICHIGAN

have been opened and others will be opened, but the period of large expansion is past.

"The objective of the plan," he explained, "was to train thousands of commonwealth aircrews in order (1) to meet and hold the enemy air strength and prevent it from doing too much damage to Great Britain, then the last citadel in Europe as well as the future springboard for an attack on Hitler; (2) to attain air supremacy; (3) to destroy enemy air power; and (4) to destroy the economic life of Germany and its allies. We can say without false pride that the air training plan has been a mighty factor in the attainment of the first three objectives. It has contributed largely to the local air superiority won in Africa and over the continent of Europe and promises to be an essential element in the realization of the final objective—that of crushing out of existence German economic might."

Minister Power revealed that Canada has trained 50,000 men for aircrew duties. "That number," he said, "would be more than enough to man 15,000 combat planes. We passed that figure several months ago, and even making allowance for the interruption in training that took place this winter owing to unseasonable weather, there is no slackening in our effort to continue to produce aircrews at a rate more accelerated than heretofore. We have not as yet reached peak production on a monthly basis and will not reach that peak production for several months. When we do, we will continue to produce trained aircrews for the duration of the war, as long as we can find men in Canada and in the United Nations of the caliber, quality, and aptitude to make aircrews."

He pointed out that the air force requires 53,000 recruits during the current year. "This provides for our aircrews and male grounderews," he said, "but does not take into consideration enlistments required for the women's division. Almost 12,000 women have been enlisted, and although present enlistments in this category are substantial, existing training facilities would enable us to accept an even larger number than those offered at present. The air training plan is now fairly well stabilized, which means that our aircrew requirements henceforth will be fairly constant, and the number required for grounderews will dwindle to a point providing only for normal replacements.

"The air force has always been in the fortunate position of having a substantial reserve of aircrew recruits awaiting training. Since the beginning of the year, however, this reserve has been considerably reduced. Potential applicants in the upper age brackets are no longer available in any substantial numbers, and as the war progresses we have to depend more and more upon the group of young men becoming of enlistment age each year."

Construction of units is almost at a standstill, Power revealed. "New schools, other than those already planned, are not contemplated at the moment," he said. "We are, however, planning for additional accommodation for men and machines at certain types of schools, but brought about largely by new and changing requirements in the aircrew categories and in the methods of training the men.

"With regard to aircraft, the new Combined Training Organization requires, naturally, more than the old. We now have over 10,000 training aircraft. We will need many more before we are through. And we now have the assurance that, largely due to Canadian production—in fact, entirely due to Canadian production—these requirements will be met, insofar as certain categories of training aircraft are concerned. But we need not be complacent about numbers. The airplanes are not always serviceable, and though we did not come to the dead end—which I feared might be possible some 18 mo.

Acme for Action
Today's war of movement goes into even faster action as the 'round-the-clock allied air attacks soften up enemy-prepared positions, blast supply lines and wreck armament plants.
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STREET SCENE—*194?*

WHEN WILL total Victory come? No one knows, but this is certain: inexorably, retribution draws nearer the monster minds that opened the floodgates of war and drenched the world in blood and sweat and tears. America's armed might and the astounding production performance of Industry leave no doubt as to the final victory. The Joyce Machine Company is grateful for the privilege of contributing materially to Industry's proud record, with millions of dollars worth of assemblies and precision parts for America's leading war plants—and for the Army and Navy as well.

When Victory comes, Americans will once again take up their normal pursuits—and normal buying habits. They will look for products long denied them by the exigencies of war-making. And they will have ample funds with which to satisfy their peace time needs. Will *you* be prepared to fill those needs—or at least be able to start on an even footing with competitors? The broad experience and innate ingenuity of Joyce's engineering staff may prove a pay lode for you in planning production of your postwar products. If it can be made better, faster or cheaper, Joyce "know how" will find the way. A Joyce representative will be glad to explain in detail the many advantages we can offer.

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ago when I pointed out to the House that owing to the hard usage and the shortage of spares we might be in a difficult position—there are times when there are delays, and we still have our days of anxiety. And there are certain types of machines for certain special types of schools which are very difficult to obtain.

"With regard to the number of schools under the original contract to produce the number of graduates then envisioned, there were to have been established in Canada a maximum number of 74 schools and other units. A comparison of the original plan with the actual situation as of Mar. 31, 1943, indicates that we almost doubled that. There are actually 154 schools in operation today. In many cases schools have twice the capacity originally planned, so that these figures do not reflect the full development which has taken place."

Minister Power further revealed statistics of distances flown by Canadian planes, operating in the training organization. "The average miles flown per day in the training plan," he said, "is 2,006,626, a distance equal to 80 times around the earth at the equator. The total miles flown in Mar., 1943, were 62,205,415, a distance about equal to 260 trips to the moon. The miles flown in the first quarter of 1943 were 162,569,510. The cumulative number of miles flown by the joint air training plan from its inception to Mar., 1943, totalled 6,588,098,593, which is equal to 71 trips to the sun."

They Skyblazed Africa "Way Back When"

(*Continued from page* 197)

been developed from England, via France, Italy, and the Mediterranean, as far as Mwanza (Tanganyika), passenger and mail services beginning on Feb. 28 of that year. Regular services on the whole route began Jan. 20, 1932.

Thus until the spread of the present war to the Mediterranean, a passenger made the journey from Britain to South Africa in five days. Leaving Southampton, England, in the early morning, he stayed the night at Athens, after refueling stops at Marseilles, Rome and Brindisi. By noon of the next day, he was in Alexandria; and he rested the second night at Wadi Halfa after stops at Cairo and Luxor. Following the Nile, he journeyed on the third day to Khartoum, Malakal, Port Bell, and Kisumu. The fourth day saw him at the airports of Dar-es-Salaam, Lindi, and Mozambique, and by the end of the fifth day, on which he called at Beira and Lourenco Marques, in Portuguese East Africa, he

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3. **It lasts longer because it is practically unbreakable.**

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PLOMB

reached Durban, 7,245 mi. from his starting point.

On the route through Africa he passed through three important air junctions. From Kisumu, Wilson Airways ran a network of lines through Central Africa, and from Beira, Rhodesia & Nyasaland Airways operated routes throughout the Rhodesias.

By far the most important spur line, however—especially in view of its development in the present war by Britain and America—was that which runs directly across Africa from east to west, from Khartoum to Lagos on the West Coast of Africa. This is one of the most remarkable air routes, passing through El Obeid, El Fasher, and El Geneina (all in the Anglo Egyptian Sudan) Fort Lamy, French Equatorial Africa, and Maiduguri, Kana, Kaduna, Minna, Oshogbo, and Lagos (all in Nigeria).

Organization and development of this route is one of the epics of air transport. Out of a wilderness of jungle, scrubs, and desert, amid sandstorms, tornadoes, and torrential rains, beset with all the dangers and pestilences of the tropics, a small band of British pilots and engineers carved an air route long before this war. This route in the war against Nazism, was to become the United Nations' vital link with the battlefields in the Near East.

Serious attempts to span the Continent across the center from east to west were first made in 1930, when three RAF aircraft made the flight in short stages. Storms and a crash in a remote jungle were to a large extent compensated by enthusiasm of the natives, who saw a new link with the world through the coming of the "great bird."

At Maiduguri and Kano, crowds of over 30,000 waited from sunrise for the aircraft to arrive. Chiefs and their people were in gala attire; the beat of tom-toms almost drowned the drone of the engines. The natives were incredulous when they saw the RAF men step from the airplanes; it could not be conceived that anyone could travel in such a contraption. One widespread belief was that the plane had been wound up like a clockwork toy at the last stopping place.

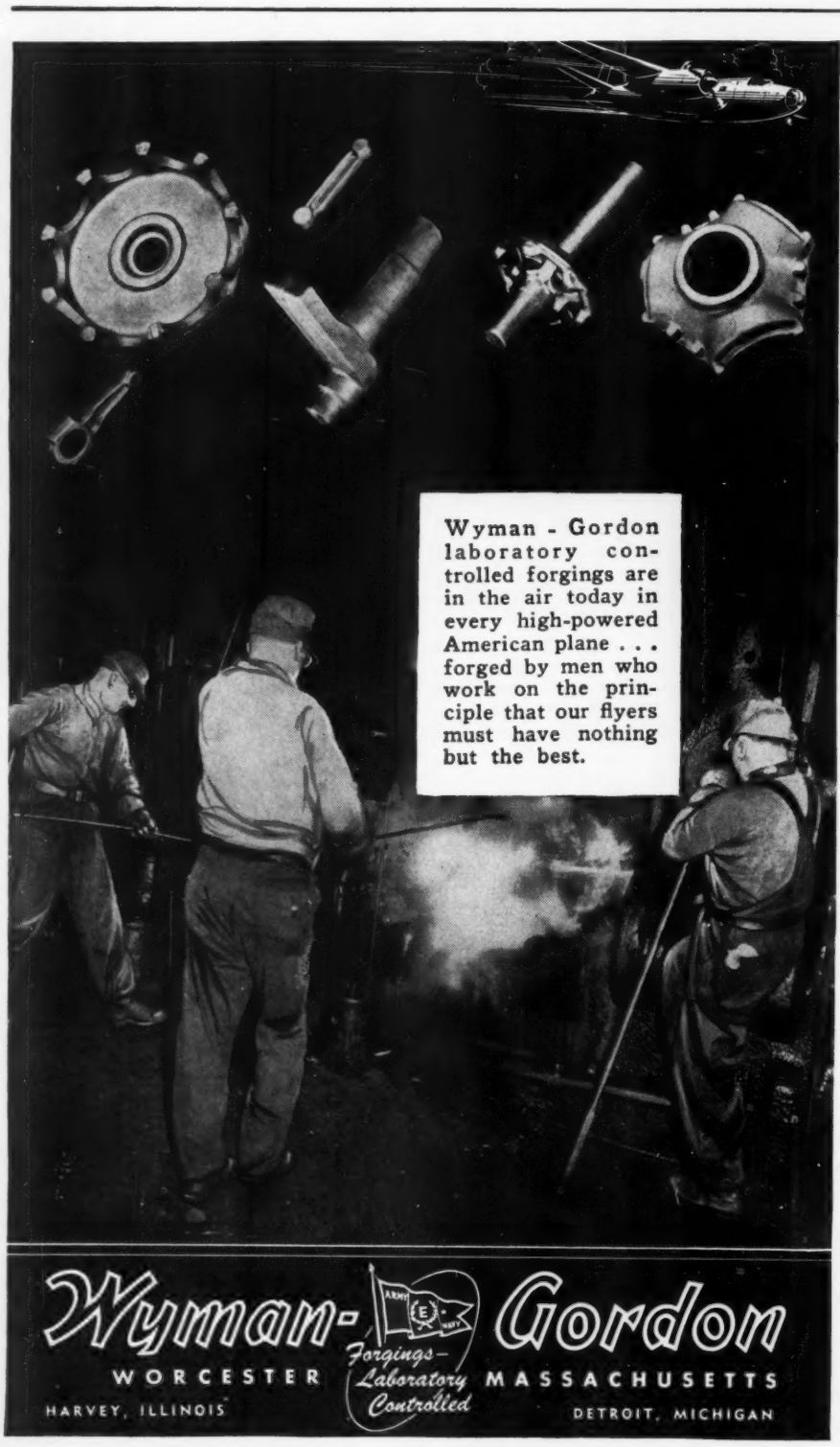
Then, in 1936, Imperial Airways began to establish this 2,500 mi. route on a permanent basis. First pilot on the route was Capt. O. P. Jones. After his inaugural flight, the service was taken over by Capt. R. O. O. Taylor, First Officer (now Captain) K. M. Cass, and Flight Engineer H. Morris. The aircraft used were DeHavilland 86's named "Delia" and "Daedalus."

Dromes on the route were little more than clearings on the bush. Facilities for maintenance, accommodation for night stops, or for preparing food were practically nil. The crew carried their own mattresses and lived in grass huts. Morris, besides filling the role of engineer, was also steward, looking after food for crew and passengers.

Khartoum, the eastern terminus, was well equipped for maintenance work, being on the already existing Empire route to South Africa, but the first night stop at El Geneina, in the Sudan, brought the first taste of desert life. Gazelles were often all over the clearing intended as an airfield, giraffes stood placidly around to watch the landings, natives stared awe-stricken as the old DH-86 came to earth.

Great help was afforded by all sorts of people in the remote places along this difficult route. M. Stratis, Greek agent at El Fasher, provided the first crew with food when otherwise, they believe, they might have starved. Then there were the French Colonial troops at Abesha, who were hospitality personified—a pleasant contrast to the field, which was like a golf course studded with bunkers.

Kano, in Nigeria, was one of the brightest spots on the route, although accommodations were not very good. Members of the West African Frontier Force showed their appreciation of the new air service by helping the first crew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THE TUBING YOU *can't* SEE!

This set of three rotor blades is being carefully matched prior to installation on a Helicopter. Note large end of step-tapered tubing extending from root of blade, ready for attachment to rotor hub.

Hidden within each rotor blade on the Sikorsky Helicopter is a Summerill step-tapered tube that has been engineered to meet the obviously severe requirements.

More than 17 feet in length, these seamless steel rotor-blade spars are reduced in 6 steps from 2" O.D. x .125" wall to 5/8" O.D. x .050" wall. Almost perfect uniformity of weight, center of gravity, stiffness and other physical characteristics are required in the matching of these rotor spars.

It is but natural that those who are developing and building rotary wing aircraft turn to Summerill for the solution of their tubing problems. Being specialists in the field of tubing specialties, Summerill maintains a research department that is constantly working with industry in the development of new sections, shapes and sizes to meet unusual needs.

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Common causes of mechanical failure of automobiles are vibration-loosed connections. And loose connections can result in anything from an annoying body squeak to a loose wheel—and a serious accident. The answer to any vibration-loosed connection is a vibration-proof fastening. After Victory, automobile manufacturers with an eye to added driving safety will protect their cars with Boots Self-Locking Nuts which withstand severest vibration.

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Cargo planes are performing heroic service ferrying men and supplies to the fighting fronts. Almost always loaded to capacity, they are constantly subjected to terrific vibration stress by engines which must strain to the limit to lift the big ships from the ground and keep them in the air. That these planes are able to "take" severest vibration without "coming apart at the seams," is due largely to the vibration-proof Boots Self-Locking Nuts which protect them.

Boots Nuts are not only tough, they are also lighter than other nuts, save many pounds on each plane . . . thus allow for more cargo. In addition, they can be used and re-used as often as desired—literally "outlast the plane." Boots Self-Locking Nuts, standard for every type of U. S. aircraft, meet the exacting specifications of all government aviation agencies.

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in every possible way. It was at Kano that the first hangar on the route was built.

Kaduna, Minna, and Oshbogbo, refueling stops between Kano and Lagos, were merely spots in the desert. Lagos, Atlantic coast terminal of the new route, was then a growing town. Still, most of the natives had never before seen an airplane. As a result, so many crowded around that they had to be chased away with a blowtorch.

Lagos, very humid, had a serious effect on the plane. Being constructed of wood, it warped badly and the fabric sagged, and by the time the return journey was ended at Khartoum, the timbers had shrunk. Also, there was the difficulty of spares, which had to be carried in the plane. On every journey, the rear freight compartment held such things as a tire, tail wheel, cylinder, magneto, spark plugs, jacks, etc.

In the development of Britain's Empire air routes, Alexandria was a focal point. From here the route ran southward to South Africa, with its several spur lines; eastward there was to be the airway across the Persian Gulf to India, the Far East, and Australasia.

The first link, between England and Alexandria, was a relatively simple matter so far as flying was concerned. But problems, mainly political, were numerous. First of all, British aircraft were not permitted to enter Italy from France, and the only alternative was to fly across the Alps. This was considered too hazardous a flight in those days, so passengers entrained for Genoa, where they boarded a flying-boat for Alexandria.

Later on, British planes entering Italy from France were again banned from Italian ports, hence the Mediterranean crossing had to be made from Salonika, Greece. This meant a circuitous route through Central Europe, which was difficult in winter, especially in Southern Yugoslavia. In fact, the journey from Skoplje, Yugoslavia, to Salonika, had to be made by train in winter. And later again, Empire route passengers had to go from Paris to Brindisi, Italy, by train.

Similar troubles beset Imperial Airways on the first stage of the extended route from Egypt to India. As early as 1921, the RAF had begun regular service for official mail from Cairo to Bagdad.

Still using combat planes flown in World War I, the RAF made extensive air and ground surveys of the route over the Syrian Desert from Amman, Transjordan, to Bagdad. This was in some respects even more difficult than the African survey, for there are few landmarks in those sandy wastes. The ground parties, besides preparing landing strips, had to plow deep furrows which could be seen from the air. When it was decided that this link should be part of the com-

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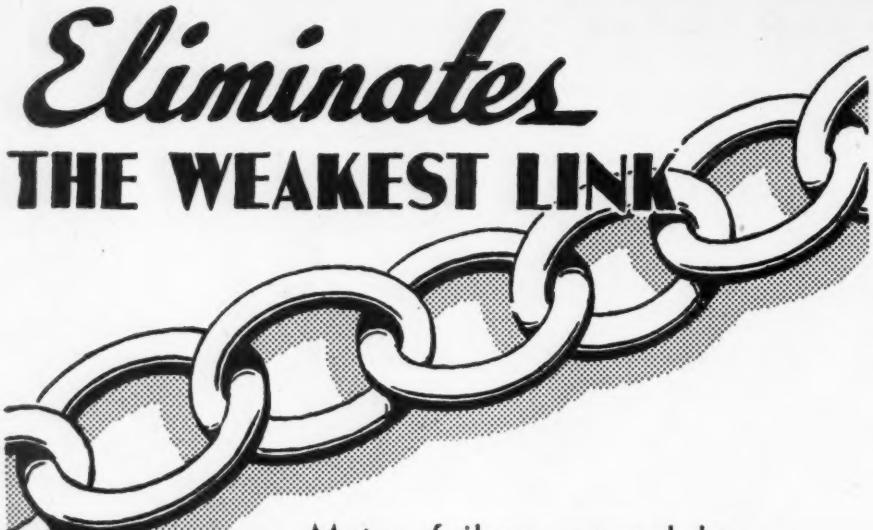

Motor failure, caused by small gasoline, oil, and power leaks, was once aviation's weakest link. When **TITESEAL** was developed at Wright Field, it stopped these leaks and made aviation safer.

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mercial air route between Africa and India, still greater work had to be done. Additional radio communications had to be established, and arrangements made for a continuous supply of fuel and accommodations for passengers had to be provided in most desolate spots, sometimes at landing grounds in the desert which were identified only by numbers.

At this time radio-telephony between aircraft and the ground had been developed in Europe. With the introduction of a telescopic mast to supplement the ordinary trailing aerial, which could not be used on the ground, and with a small power-driven dynamo, each plane became a mobile radio station able to communicate with ground stations whether in the air or on the ground.

Also, it was necessary, besides feeding passengers and providing beds and other equipment, to protect them from sandstorms and pests. At Rutbah Wells, a lonely spot in Iraq, there was an additional problem—hostile tribes. To safeguard crews and passengers a fort was built there.

It was in 1926 that Imperial Airways took over the route as a commercial proposition. The enormous difficulties of terrain and climate were matched by political problems. To reach an agreement with Persia (Iran) appeared an almost insurmountable obstacle, but finally a short term agreement was signed. It was extended beyond the set period, but then Persian authorities were reluctant to continue. Thus Imperial Airways were obliged to change the route to the Arabian side of the Persian Gulf, one of the hottest and most desolate regions in the world, along which it still runs. New landing fields had to be selected and prepared and, not the least problem, negotiations had to be conducted with local sheiks for the use and protection of the landing grounds selected.

Meanwhile the RAF pushed further along the route toward Australia. It developed the airline from Calcutta to Singapore, and in 1933 a new company, Indian Trans-continental Airways, began to operate jointly with Imperial Airways across India, and on through Burma to Singapore. The stage to Calcutta was opened in July, 1933; to Rangoon in September; and to Singapore in December. Final stage, to Australia, was placed in the hands of Imperial Airways' Australian associate, Qantas Empire Airways, and, with the cooperation of the Dutch authorities in the East Indies, the route to Australia opened on Dec. 8, 1934.

Later, Tasman Empire Airways took up the Sydney to Auckland section making a through route, Britain-New Zealand, then the world's longest commercial air route—15,000 mi. from end to end.

A passenger from England could thus

"Greatest Piece of Transportation in This War"

The Home Front*

By TOM TREANOR

. . . The greatest piece of transportation in this war is the Douglas DC-3 transport plane . . . (which) has won more battles than the jeep.

. . . without the DC-3 there would never have been the weblike system of military airlines all over the world . . . now known as the Air Transport Command. Without the DC-3 the Air Transport Command would have been set back a good year.

And without the Air Transport Command there's many a battle in this war would have gone slower or even completely sour.

To give one example, ever since the fall of the Burma Road the Chinese war has been supplied almost entirely by the DC-3.

Don Whitehead of the Associated Press tells me that during the Tunisian campaign 15,000 casualties were evacuated in DC-3's without the loss of a plane or a life.

A surgeon told him that a principal reason for the extremely low American battle death rate was the rapidity with which the wounded could be brought to fully equipped hospitals by plane.

During the western desert campaign Whitehead says that without the supplies which were ferried to the front by DC-3's the 8th Army's advance would have been slower and the Africa Korps could have dug itself in for determined stands instead of being nearly routed.

"We'd often see them coming over the desert in formation," he said, "flying so low they seemed no more than five feet above the ground, rising and falling with each ridge. Sometimes they'd come into advance airports while the dust of enemy bombings still hung in the air."

*"The Home Front" is a daily feature in the Los Angeles Times. The foregoing are excerpts from this column which appeared Sept. 6, 1943. Tom Treanor is literally a "self-made" war correspondent whose colorful exploits on many fronts have won him acclaim. Reference to the DC-3 also applies to the C-47 Skytrain and C-53 Skytrooper, basically identical models. This material is reprinted with the appreciation of the men and women of Douglas who build the planes Treanor praises.

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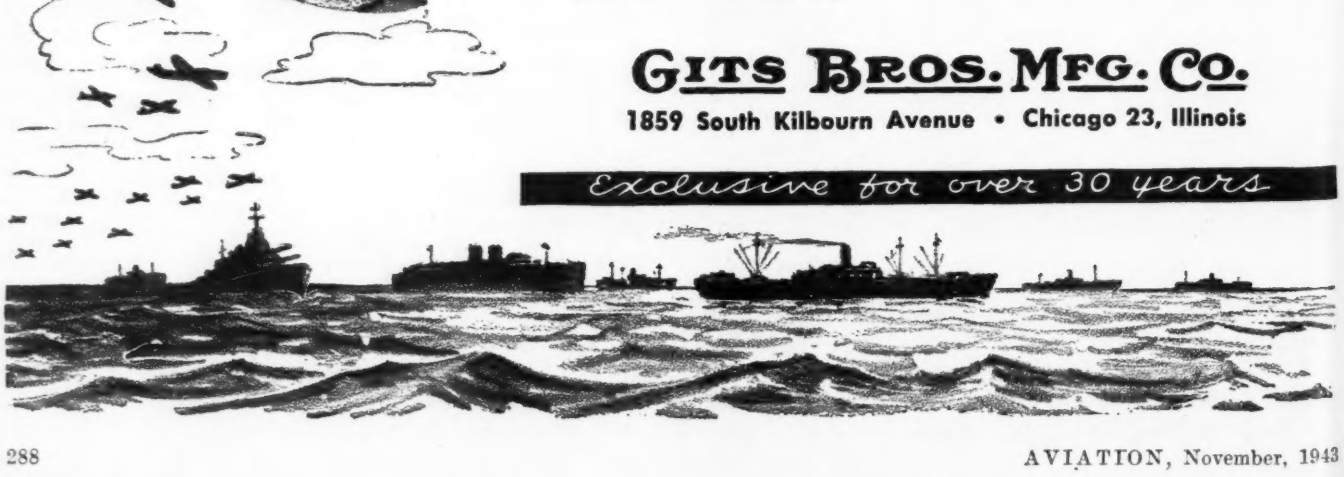

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be in Australia in ten days. Arriving at Alexandria in the forenoon of the second day, he went by way of Tiberias, Palestine, and Habbaniyeh to Basra, Iraq. By the evening of the third day, he had crossed the Persian Gulf to Karachi, having called at Bahrein; at Sharjah, an ancient fort on the Oman coast; and Jiwni in Baluchistan. These are still regular stops on the BOAC route to India.

Across India to Calcutta were two choices of route, by flying boat via Raj Samand, Gwalior, and Allahabad, or by land plane by way of Jodhpur, Delhi, Cawnpore, and Allahabad.

Fifth day of his flight saw him at Akyab, Rangoon, and Bangkok. From the last mentioned place Imperial Airways ran a feeder line of 1,178 mi. to Hong Kong through Udorn, Thailand, Hanei, Tongking, and Fort Bayard in French Indo China.

The main route continued to Koh Samui, Thailand, and Penang Island, Malaya, to Singapore. The seventh day took the passenger to Sourabaya and Batavia, Java. Bina and Koepang, NEI., and Darwin were his calling places on the eighth day. Going along the Australian Coast by way of Groote Eylandt and Karumba, his last night-stop was at Townsville, with Sydney being reached the tenth day.

Thus were Britain's overseas air routes developed. After that first flight on Coronation Day in 1911, air routes grew which covered most of the British Commonwealth. The present war has checked development of British air transport, mainly through the shortage of modern transport aircraft, due to first preference being given to combat planes. But some new routes have been opened to serve the needs of the war.

The enterprise which characterized the opening of the routes from England to South Africa and the Antipodes stood Britain's Merchant Air Service well in wartime. When the Mediterranean was closed to civil flying, a new 5,000 mi. route from Britain to West Africa was opened on a few hours' notice to connect with the Trans-African route. The North Atlantic flying boat service, started just before the war began, was continued despite the ban on radio aids and the giving of weather information; some of the pilots went in Nov. 1940, to Canada to organize the ferrying of American-built bombers across the Atlantic, and finally to operate a two-way ferry service between England and Canada.

This service, still operated by the British Overseas Airways across the most difficult winter route in the world, has been the outstanding achievement of British civil aviation in wartime.

Today, British Overseas Airways Corp. operates some 40,000 mi. of routes. Since the beginning of the war, the corporation has ceased to operate as a com-

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Clare "Custom-Built" Relays for applications where vibration is a factor employ a "fatigueless" beryllium copper hinge. This allows a simple, compact unit that insures uniform armature movement up to millions of operations . . . no special anti-vibration springs are needed . . . no bearings to chatter and wear.

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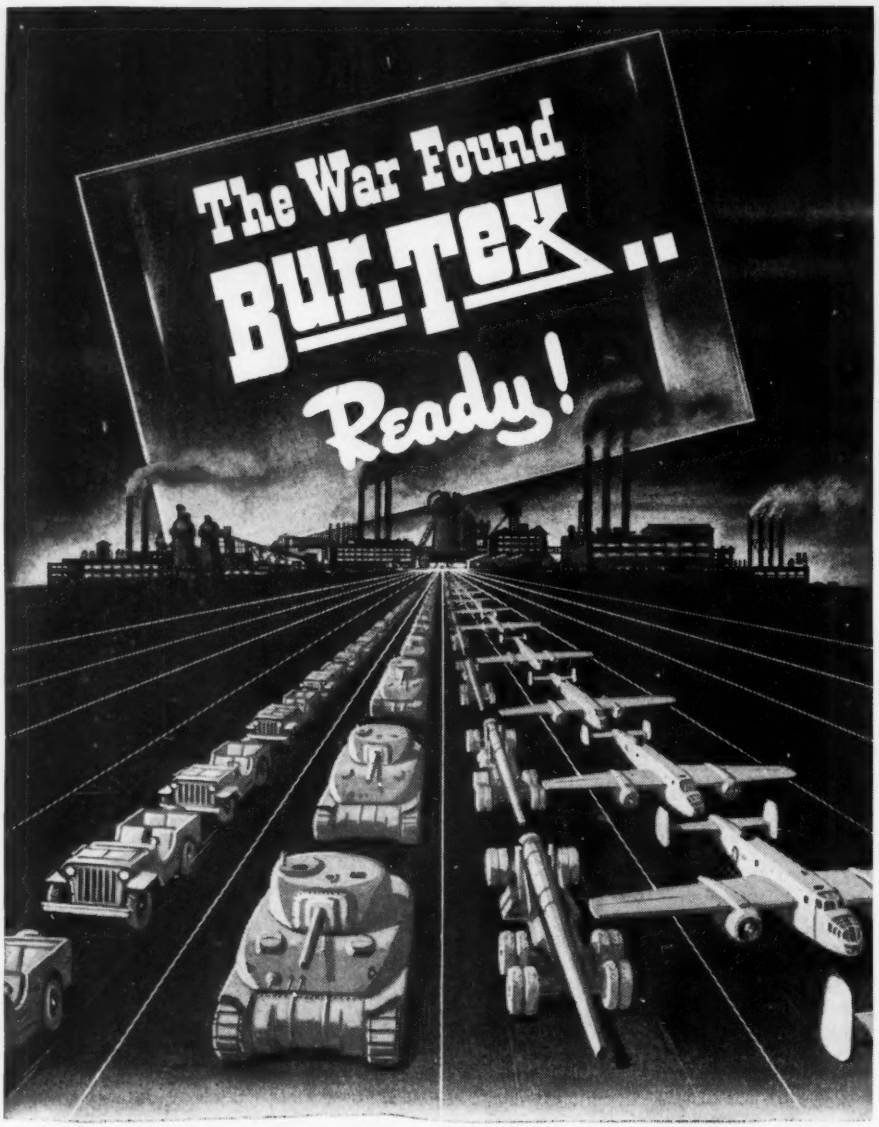
Hinge of "fatigueless" beryllium copper insures long life under vibration.

"Custom-Built" Multiple Contact Relays for Electrical, Electronic and Industrial Use

CLARE RELAYS



When tremendous wartime demands caused supplies of rubber and other materials to dwindle rapidly, BUR-TEX *impregnated* felt fabrics got the chance to prove their amazing versatility. From far and near came appeals for new fabrics that would solve the problems of companies on war production — a material for catwalks on bombers, linings for planes that must have vibration and sound deadening qualities and provide insulation at the same time. Also gun blast blankets for planes, mats and gaskets for jeeps, crash pads for tanks and scores of other applications. *All* these problems were solved with BUR-TEX fabrics — some of them requiring the development of entirely new combinations of felts and impregnated felts.

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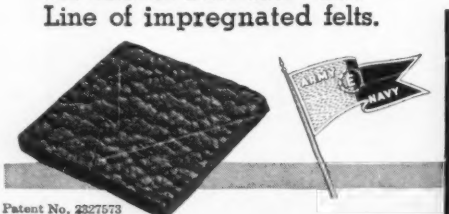

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AA's Propeller Shop "Keeps 'Em Turning"

(*Continued from page* 208)

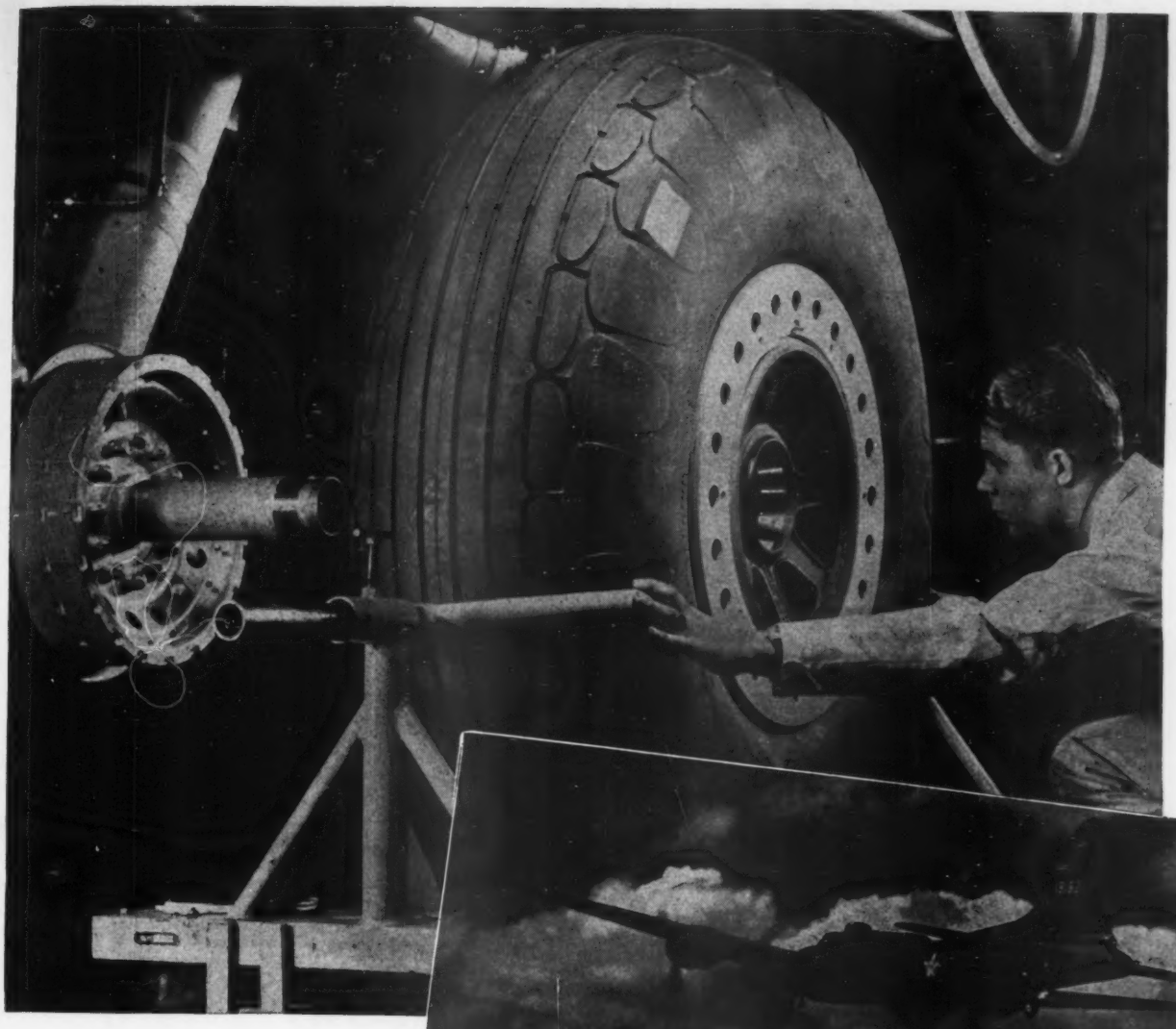
electric sander using No. 180 "Lightning" paper. This process removes all scratches, etc., excepting circular pits, which are disregarded because they do not affect the blade in any way. In order to keep an extremely close check on the weight of the blade during this grinding, the blade is mounted on a weighted arm, which balances at the correct weight of the blade. This permits a running check on the weight of the blade as the work progresses.

During this time the thickness is measured at each station when it is reached by the grinder. After the entire surface is rough ground, the blade is removed from the balance and accurately weighed on a platform scale beside the bench. If the weights of all blades are not the same, further grinding may be required. The surfaces are then given a smooth grind with No. 320 "Lightning" paper and buffed to a high polish. This operation is performed under an exhaust hood which draws off all dust and safeguards the mechanic. Polished blades are kept in a rack located sufficiently high above the floor to obviate any danger of damage from contact with moving objects.

Parts Routing

Parts other than the blades are cleaned and then given a close visual inspection (Fig. 6). After this, the Magnaflux is used to detect cracks or hidden defects. The date of the Magnaflux inspection is etched on the spider and the two halves of the hub. Any parts requiring plating are sent to the department handling this work.

During first assembly, the spider and barrel are checked for concentricity. Maximum tolerance is .004 in., but if the parts are *measurably* off center, the difference is taken up by means of shims. This also entails shimming the blades in the opposite direction to restore the over-all balance. This balance is checked (Fig. 7) as often as is considered necessary during the entire assembly operation. If added weight is required, washers are added inside the hollow shank of the blade, any number up to nine being permitted. If a difference in weight, less than that of a washer is



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says

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Easy does it

says the Pilot

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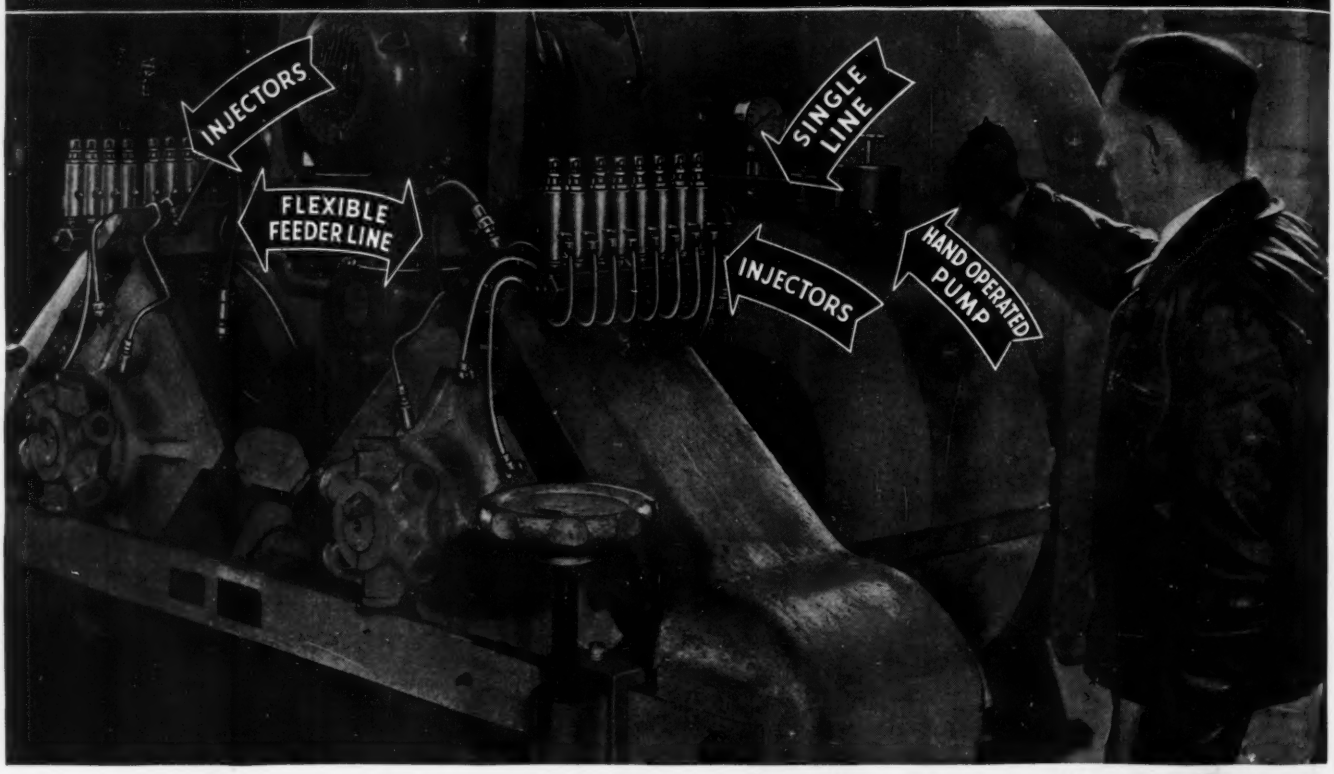

War Production Can Be Kept Going At Top Speed!

... Now instead of requiring a long shut-down, a machine can be kept running, and *all* bearings lubricated with a few strokes of the pump ... It's possible when the machine has been equipped with a

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CENTRO-MATIC LUBRICATING SYSTEM

It doesn't take a large force of service men to lubricate machines equipped with Lincoln Centro-Matic Lubricating Systems ... Under this modern method one man can do the whole job in a fraction of the time it would take several men to contact each individual bearing.

Illustration above shows a Lincoln Centro-Matic System installed on an angle shear.

A Centro-Matic System consists of a number of Centro-Matic Injectors—one for each bearing—and a power operated or a hand operated Centro-Matic Lubricant Pump. A power operated system can be either time clock control or push button control ... The injectors can be grouped in manifold or located separately at each bearing. In either arrangement only a single lubricant supply line is required ... Easily installed on new or old machines.

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required, small lengths of lead wire are placed inside the hollow bolts which connect the halves of the hub.

After balancing and oil-sealing, the assembly is once again tested for concentricity. Torque and pitch readings are then taken and recorded, and the propeller is covered and placed on a storage stand until it is to be used.

Review of Patent

(*Continued from page* 189)

Rifles by Chute. This patent concerns manner of arranging parachute pack to hold rifles so they will not be damaged in dropping. Pack consists of a heavy padding layer and a carrying layer, and rifles are laid across two layers at spaced intervals, after which edges of material are folded over rifle ends. Whole device is then rolled.—2,327,359, filed Sept. 30, '41, patented Aug. 24, '43, F. G. Manson and J. J. Maskey.

Rotor Speed Control of two auto-rotating rotors in an autogyro is subject of this development, where rotors are connected by means of a differential so that faster movement of one will effect pitch setting of other to bring speed of latter up toward that of former.—2,327,370, filed May 25, '40, patented Aug. 24, '43, C. G. Pullin, assigned to Autogiro Co. of America.

Flap Invention. This is for plane with monocoque wing construction having flap designed to act under all conditions of stress. Elastic connecting elements are incorporated to prevent bending stresses of wing from binding flaps against hinging movement. Elements are positioned so that there is at least one between each flap hinge pair.—2,329,133, filed Apr. 9, '41, patented Sept. 7, '43, G. P. Peed, Jr., assigned to Douglas Aircraft Co.

Steerable Landing Gear incorporates tricycle undercarriage with nose wheel controllable by pilot and so mounted that landing gear shimmy is eliminated. Wheel, which is retractable, has shock absorbing cushion mounting.—2,329,168, filed May 21, '40, patented Sept. 7, '43, J. B. Wassell et al, assigned to Vega Aircraft Corp.

Nose-Wheel Mounting. This concerns tricycle landing gear with specific design for mounting of a castered wheel. Shock absorbing means is provided, and castering device has positive centering means to prevent shimmy of undercarriage.—2,329,441, filed July 21, '41, patented Sept. 14, '43, S. M. Parker, assigned to Automotive Products Co., Ltd.

Dual Brake Device for trainer planes is arrangement to prevent student from applying full braking force to landing wheels and cause nose-over. Meantime device permits instructor to apply full force when needed.—2,327,427, filed Apr. 24, '40, patented Aug. 24, '43, C. Hollerith, assigned to Hayes Industries, Inc.

(*Turn to page* 295)

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Permoflux Engineers, through the control and development of new techniques, have literally carried headphone performance from the laboratory right into the battle areas themselves. The extra sensitivity, wide frequency response and high overall operating efficiency of Permoflux Dynamic Headphones make possible improved intelligibility of vital messages under the most adverse noise level conditions. Today they are helping our boys win Victory — tomorrow they will be available to all.
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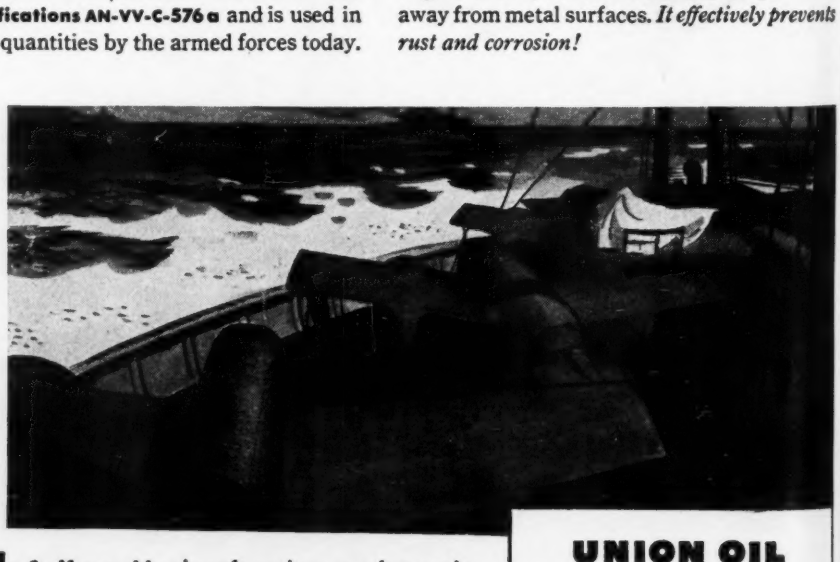
1. When the U. S. first began to ship aircraft engines all over the world, the "weather" inside those engines was a big problem. It was completely unpredictable. Condensation was apt to form at any time. And when it did, engines rusted.

Immediately a request went out for a preventive that would stop rust and also neutralize acids caused by fuel residues left over from test runs. They got what they wanted. Union Oil Company came up with a product called Stop Rust B that can deliver a motor in "factory-perfect" condition to Africa, Salamaua, or the Aleutians. **It meets specifications AN-VV-C-576a** and is used in large quantities by the armed forces today.

2. Stop Rust B contains special compounds diluted with a top-notch lubricating oil. It is a preferential wetting agent that covers and protects metal surfaces completely. It won't drain off for months. It stays put as long as the engine is idle, neutralizes acids, keeps water away from metal surfaces. *It effectively prevents rust and corrosion!*



3. Stop Rust B has another important feature. It leaves no harmful residue when engines are put back into service. No flushing is necessary. The residue actually improves the lubricating oil—gives it a "break-in" quality.

4. So if you ship aircraft engines or other equipment that requires internal protection against rust and corrosion, get in touch with Union Oil Company of California by phone, wire, or letter. Stop Rust B can be supplied in 53-gallon barrels or bulk.

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Portland · Seattle · Honolulu
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Plane Window Construction. Here, fuselage frame is so formed that relocation of window openings will not lower strength of craft. This is accomplished by providing a longitudinal beam above and another below window line with structural members connecting beams between windows. Patent states relocation of latter will then not affect strength of framework.—2,327,636, filed Feb. 20, '40, patented Aug. 24, '43, J. Gerber, assigned to Lockheed Aircraft Corp.

Air Conditioning Apparatus. Improvement is for stratosphere pressure cabins of planes. Heat exchanger is positioned in wing, and airflow through it is created by slipstream as plane flies. Arrangement is stated to permit use of large heat exchanger without sacrifice of vital space.—2,327,737, filed Mar. 5, '41, patented Aug. 24, '43, T. S. Pendergast, assigned to Universal Cooler Corp.

De-Icing Arrangement. Here, series of tubes extends along leading edge of wing, and portion of exhaust gases from engine passes through tubes. In turn, some of this gas escapes both on under and upper wing surfaces to act against icing.—2,328,079, filed Mar. 26, '41, patented Aug. 31, '43, J. Goodmon.

Prescriptions For Head Cracks

(*Continued from page* 143)

and rivets were heat-treated at 920 deg. F. for 30 min., quenched in cold water, stored in ice water, and driven immediately upon removal from the ice water. Five different diameters of flat driven heads were used, and no head cracks were found in any rivets. Five specimens were prepared for each sheet thickness and head size. After aging one week at room temperature, the joints were tested in the 40,000-lb. Amsler machine using Templin grips.

Results of these tests (Table III and Fig. 7) indicate clearly that a reduction in size of driven head is accompanied by a reduction in ultimate strength of the joint whether failure is in the rivet or in the sheet. A study of the types of failure encountered, together with a comparison of the stresses developed with the normal capacities of the rivets and sheet to withstand shear and bearing, leads to the conclusion that the diameter of the driven head should not be less than 1.3 times the nominal shank diameter. In fact, if the d/t (diameter of rivet/thickness of sheet) ratio is greater than about 4, it appears that head diameters of 1.3 and even 1.4 times the shank diameter may be inadequate to prevent early failure in single-riveted lap joints.

Conclusions

Judgments based on the results of the various tests of $\frac{1}{8}$-in. and $\frac{1}{4}$-in. 24ST

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rivets described herein, are as follows:

1. Aircraft rivets of 24ST, heat-treated within the specified limits of 910 deg. to 930 deg. F. and driven with flatheads having the commonly used diameter of 1½ times nominal shank diameter, may be expected to develop shear cracks in the driven head if the interval of room temperature aging between heat treating and driving exceeds 5 to 15 min.

2. Such head cracks, however, do not adversely affect the static tensile strength, the static shear strength, or the shear fatigue strength of the driven rivets. Furthermore, the resistance to corrosion is not appreciably reduced. Only valid objection to such head cracks would seem to be the poor appearance of the cracked heads. Therefore, cracked-head rivets should seldom be replaced, particularly when the cracked heads are in an inconspicuous location in the finished structure.

3. All heat-treating and reheat-treating of 24ST rivets should, of course, be done at temperatures within the specified temperature range of 910 deg. to 930 deg. F. Use of temperatures below this range, while reducing the tendency for head cracking, lowers the shear strength and may adversely affect the resistance to corrosion of the 24ST rivets.

Use of temperatures above this range promotes head cracking, lowers resistance to corrosion, and, if carried far enough, may cause quench cracking, grain-boundary melting, and reduced shear strength.

4. To minimize head cracking, the interval of room temperature aging between heat treatment and driving should be held as short as possible by refrigerating the rivets immediately after quenching and by transferring them from the refrigerant to the work without delay. Increasing the interval of room temperature aging increases the pressure required to drive and the tendency for head cracking without any pronounced beneficial effect on the shear strength of the driven rivets.

5. Decreasing the diameter of the driven head of a rivet decreases the tendency for head cracking but may also decrease the shear strength of the rivet and its resistance to being pulled through the hole in lap joints in thin sheet.

In any lap joints in which the sheet thickness is not less than ¼ the shank diameter of the rivet a reasonable balance between cracking tendency and rivet strength seems to be achieved if the diameter of the driven head is about 1⅓ times the nominal shank diameter. In joints in which thinner sheets are used, a somewhat larger diameter of driven head up to about 1½ times the nominal shank diameter may be desirable.

O.K. for FLIGHT
—thanks to the Andover Auxiliary Power Plant

The Andover Auxiliary Power Plant consists of a two-cylinder air-cooled engine driving a 28.5-volt generator supplying a continuous power output of 5 K. W. with a peak load of 7½ K. W. Its complete weight with generator is only 116 lbs.

INSTALLED in the ship, this compact, lightweight, rugged power plant makes each bomber *completely independent* with a source of inexhaustible power for preflight tests.

Before the take-off, every precaution is taken to insure a successful bombing expedition. Instruments, turret operation, bomb-bay doors, radio, interplane communication system, heating and all vital accessories can be checked with the Andover Auxiliary Power Unit.

With the use of *continuous* electric power supplied by the Andover Auxiliary Power Unit, this ship is ready for action over enemy territory—where vital bombing equipment must not fail.

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Engine Control Simplifies Piloting

(*Continued from page* 258)

the maximum power output obtainable without detonation as a function of spark advance, while Fig. 7 shows the form of the relationship between specific fuel consumption and spark advance.

A current engine of the type for which these curves were drawn would employ a constant spark advance of about 25 deg. for all parts of the operating range. This also happens to give undesirable "kick-back" tendencies during starting. An additional cam and lever arrangement could be made to give an automatic spark advance which would provide a retarded spark for starting and idling, a high advance in the cruising range, and a progressively smaller advance for the higher power outputs. An arrangement of this sort has been included in the design of one control mechanism.

While it may seem that these additional cams and levers would give a very complicated control, the actual device would be fairly simple. The cams and levers could be placed side by side on shafts *A* and *B* so that a compact unit would be obtained. Such a unit should not only relieve the pilot of a great deal of work but should also give improved airplane performance.

Simmonds now has in development more advanced designs incorporating some of the above mentioned features.

Plant-Within-Plant For Peak Production

(*Continued from page* 163)

els to a 30-in. engine lathe, Doall saws, routers, band saws, shapers, drill presses, milling machines, jig borers, grinding machines in pedestal and portable models, punch presses, forming presses, shears, power brakes, die filing machines, power beading machines, and a full line of bench and hand tools.

A simple job may be handled by one man, reception of the order to the finished tool, part, die, or whatnot. On a critical job when the emergency is urgent, as many as six or seven men will team up to take the work through in a hurry.

Flexibility is the keynote of the entire department, regardless of the various operations needed, the number of men required to meet the demands of a deadline, or the type of material that must be worked. There is flexibility, also, in the tolerances to which the work is held. They will vary from .0001 on the manufacture or repair of a precision tool to a wide latitude on a rough form carved out of a block of wood. Expediency and the requirements of the job determine the material to be employed and the tolerances to be worked.

In the nine general classifications into which the work falls there is enough variety to satisfy any man's urge to escape the monotony of routine. Production tools made for other departments include those intended for permanent use, temporary units to bridge the time lag required for building permanent new tools, and jigs and fixtures which may be either temporary or permanent.

Tools, jigs, and fixtures made for the experimental first-runs on new production set-ups enable the tooling and methods division to try out new ideas before freezing the methods and tools on the production line for mass output. Templates for pioneering jobs are likewise experimental in nature and are generally made of inexpensive materials for temporary use only.

Emergency repair of machine tools in any part of the plants is an especially important activity of the department. If the break-down has occurred to a key machine, no time can be wasted in getting it back into operation. The

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Effectively at low cost • Completely machinable, invisible welds • Ideal for thin walled or heavy castings in all metals.

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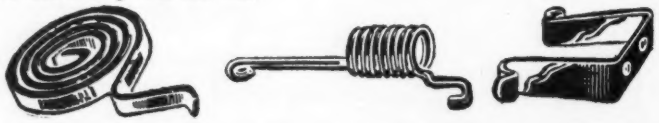

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time scheduling of a production or an assembly line is so precise that even a day's delay may seriously disrupt the flow of production.

The manufacture of temporary new tools for the first test runs of company-designed production and assembly tools is one of the more challenging duties of the department, calling as it does for ingenuity and long experience in solving mechanical problems. Here, precision is a major requirement.

Emergency die work may involve two phases: The quick forming of a temporary die to maintain production during the time needed for repairing the die or cutting a new one, and the repair or cutting of the new die. It may even involve making a few parts in the department to bridge the time gap necessary for devising a temporary die.

Because making spare parts for current models, or building repair parts for older models out of active production would interrupt the required rhythm of regular production lines, most of this work is routed into the miscellaneous parts department. The run may be for only one or two parts, or it may be for two or three hundred.

Salvage work also is a challenge to the ingenuity of the department. There are three divisions to this operation: First, salvage of parts damaged in production; second, salvage of parts, fittings, or fastenings orphaned by changes in design; and, third, salvage of parts, fittings, or fastenings misworked by other departments or by subcontractors.

An example of the latter is the part in which the subcontractor drills and threads only five holes out of six. To save transportation and time, this piece is sent to miscellaneous parts for the drilling and tapping of the sixth hole.

In trying to describe the operations of their departments, the two foreman start out by saying, "Well, we do a little bit of everything." And they end up by advising, "Look, why don't you just walk around and see for yourself."

The answer is "Gladly!"—for there are no dull moments at "Little CV."

Feeder Airline's Place In Postwar America

(*Continued from page* 117)

Nor can there be any argument that pickups involve more risk from a safety standpoint. All American has made well over 200,000 pickups without a single accident that could possibly have resulted in injury to passengers, had they been on board. During the same period, it did suffer some difficulties while making a far less number of landings on large airline terminal airports.

Our studies indicate that in most parts

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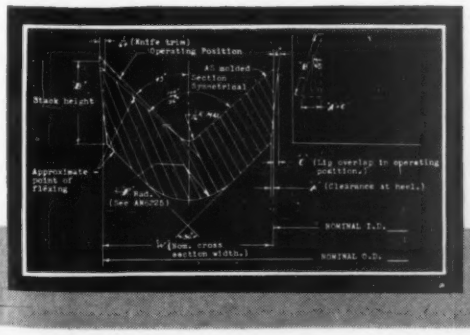
In a hydraulic packing, correct *design* and *size* are on less important than correct composition of the material. And maintaining correct design—as the drawing below clearly shows—involves producing packings with every angle and dimension held to extremely close limits. Hence the meticulous care exercised in every step of the manufacture of "PAR" Packings.

For example, when a new mold is made, every cavity in it is tested by cutting thin cross-sections from sample moldings and examining them on the micro-projector illustrated above. This apparatus magnifies the section 20 to 50 diameters and projects the image against a proportionately large scale drawing for comparison. The same method is also employed for periodically checking all molds in use.

Even with mold accuracy thus assured, every "PAR" Packing is carefully precision ground and must pass a rigid inspection before it is ready for shipment.

Right now a great deal depends upon the accuracy and correct design of "PAR" Packings . . . for millions of them are going into the vital hydraulic actuating cylinders, struts, emergency hand pumps, etc., of our country's fighting planes and bombers.

While supplying Uncle Sam's requirements is a man-sized job, our engineering department is now able to find time to work with designers or manufacturers planning new products calling for dependable hydraulic pressure seals. We invite your problems. LINEAR PACKING & RUBBER CO., State Road & Levick Street, Tacony, Philadelphia 35, Pennsylvania.



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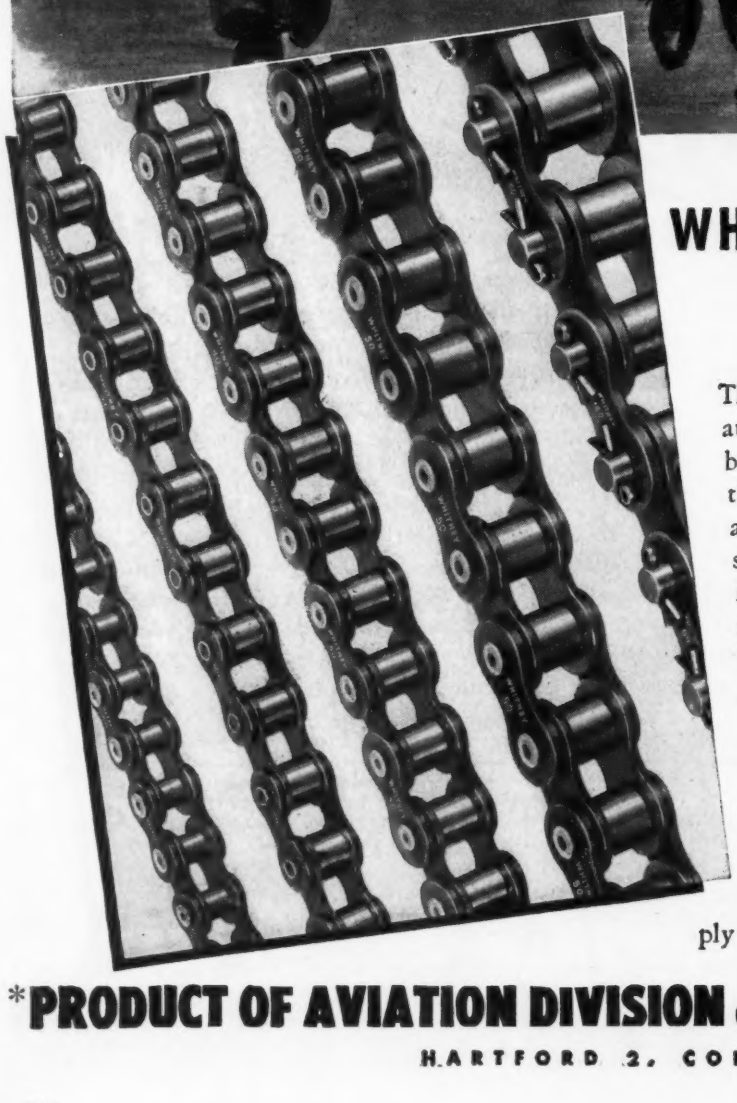
"PAR" PACKINGS

"... man your planes"



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of the United States, the average distance between points deserving feeder air service will be about 17 mi., with approximately 20 communities on each route. In the beginning, suitable landing places probably would be available at only one-half or one-third of these points. Moreover, it would not be necessary to land unless these were passengers to be taken on or off, since a strictly mail-express load could be handled with the pick-up mechanism.

This computation reduces the number of landings to be made on the average feeder line route to probably one for each four communities served, or about every 60 to 70 mi. A most satisfactory air service could be maintained on a schedule of this nature with the proper equipment.

But this might only be temporarily—for the history of air transport shows that after a line has been in operation for a comparatively short period of time, additional cities along the route establish airports in order to gain the benefit of passenger service. If it is presumed this also would happen on feeder routes, landings would become progressively more frequent until, as a few simple statistics conclusively show, it would become imperative that feeder planes avoid spending many minutes on the ground for each landing.

For example, if a plane with a 150 mph. cruising speed lands every 50 mi., and requires 15 min. for each landing (as do present day trunk airliners) its scheduled speed would fall off to only 85 mph. In order to maintain the satisfactory scheduled speed of 120 mph. under the same conditions, the plane would have to cruise at 300 mph.

On the other hand, the plane with a 150 mph. cruising speed could maintain a scheduled speed of 120 mph. over the same route if the time per landing could be reduced to only 5 min.!

This makes it obvious that the most promising approach to the problem of maintaining good cruising speeds on feeder airlines is not the usual one of trying to build faster airplanes. Rather, it is attempting to get planes through scheduled stops with a maximum loss in time of 5 min.

This can be done. But to get optimum results it will be necessary to incorporate certain features into the design of both the feeder airplane and the airport.

First, let us consider the airport. Our present-day ports have an historical background, for they are largely the result of many years of experience with types of aircraft unsuited for cross-wind operation. Early aircraft, it will be remembered, did not have brakes: consequently, it was necessary that all landings be made directly into the wind. This required an airport where a maximum length of run for a landing or a takeoff could be had in any direction.

With the increase in the wing loading factor in aircraft design, thus requiring longer takeoffs and landing runs, it has been necessary to expand airports in all directions so that runs still could be made directly into the wind. These requirements have increased the size of today's airports until they have become cumbersome and unwieldy things, far too expensive for a city to establish and maintain (a cost which air transport eventually will have to pay) and far too big to get an airplane in scheduled operation through them without a serious loss of time.

Does 15 min. lost per landing sound like an exaggeration? Let us run through a mythical landing, then decide:

Approaching the airport, it is necessary to circle to follow the traffic pattern. If this circle usually is big, it is partially so because the airport also is big. Remaining in traffic, the circle is followed until the down-wind side of the airport is reached and the ship can come in to land.

It is seldom possible to land close to the loading and unloading facilities, because of the necessity for staying in the proper line of traffic and also for using the runway that is into the wind at that

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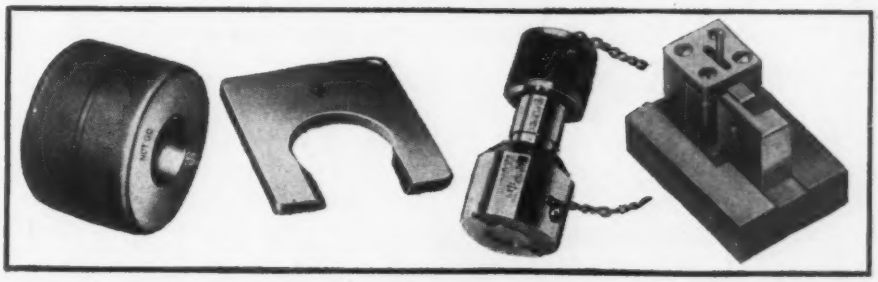

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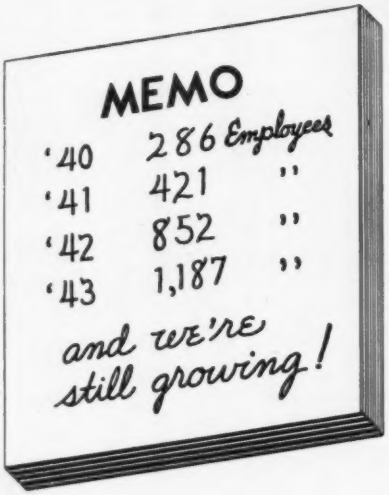

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time. To reach the loading ramp may require taxiing as much as a mile. More frequently than not, other airport traffic delays the ship still more before it is allowed to taxi in.

With passengers and freight loaded, the plane must once again taxi the long distance to the takeoff position and wait for clearance from the control tower. Once in the air it still may not be free from the restrictions of the average modern airport, for it often will be necessary to circle the airport once more in order to get headed out on the proper course. Fifteen minutes? It frequently is impossible to get away that quickly, unless traffic and wind conditions are ideal.

My purpose in recounting these well-known difficulties is not to indicate that the present method of operating from existing airports is wrong. We all know that it is necessary. But at the same time, it graphically illustrates the impossibility of trying to extend our present operating method to feeder airlines. It would be impossible to maintain scheduled speeds of more than 50 mph. if this lengthy landing procedure was required every 20 or 25 mi.

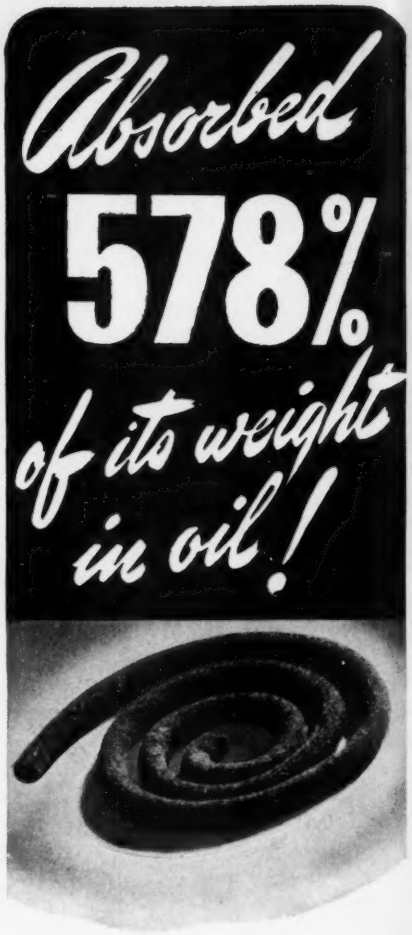
Since we obviously cannot reduce the time per landing to anything near 5 min. on these airports, it seems to us that we must think in terms of a new airport ideal for feeder airline operation.

We believe the logical answer is flight strips, laid out parallel to the course of the feeder route and long enough to permit the aircraft to land from either direction without the necessity of circling, except in the case of strong following winds.

If the feeder route should go through the town with a substantial change of direction, it would be desirable to have the landing strip laid out so that its length would be included in the angle made by the route. In other words, if the line enters the town from the north and departs to the east, the landing strip should be parallel with the north-south course or the east-west course, or laid out in any direction between north-south and east-west.

To operate from such a landing strip would require an aircraft that could be handled successfully in fairly strong cross-winds. We believe that such an aircraft can be built, and that it should have tricycle landing gear, good brakes, and good flight maneuverability.

Our studies of wind conditions in various parts of the country indicate that an aircraft of this type could be landed safely with as much as a 10 mph following wind, which would enable landings to be made "on course" at least 90 percent of the time. If the wind were stronger than 10 mph. making circling necessary to get into the strip, the delay on the schedule would be negligible, since there would be the



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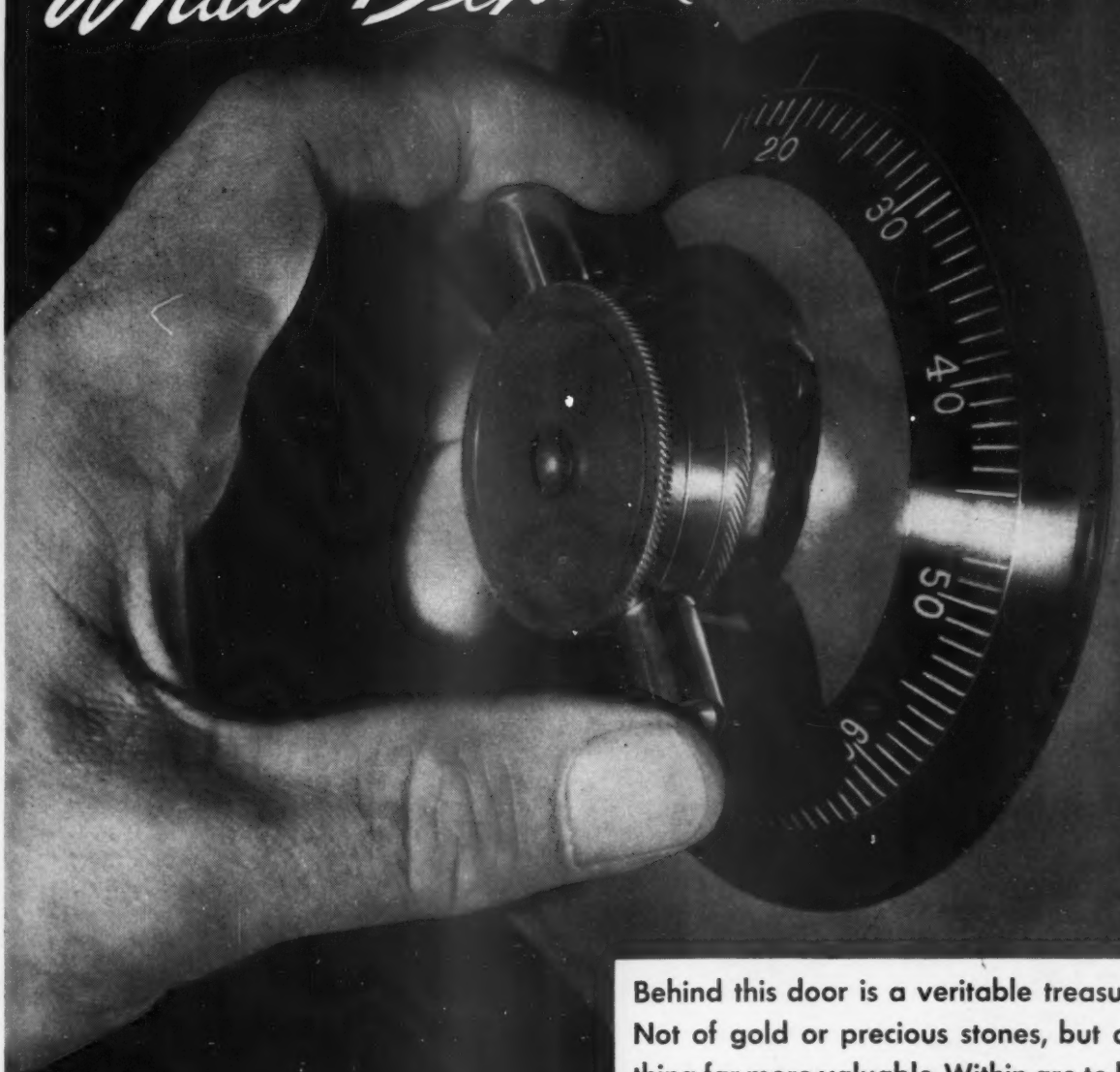

Behind this door is a veritable treasure chest. Not of gold or precious stones, but of something far more valuable. Within are to be found degrees of skill, ingenuity and craftsmanship rarely matched.

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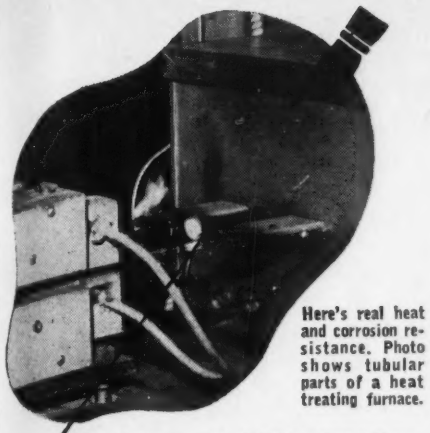

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compensating increase in the aircraft's speed when it was flying toward or away from the strip with the same strong following wind.

A further speed-up in time per landing would be possible if the aircraft utilized high lift devices, thus had a low landing speed. This would permit having landing strips long enough to allow a landing and takeoff without any taxiing whatever—the passenger station being located halfway down the strip. Should traffic be unusually heavy, requiring a double landing strip for reasons of safety and convenience, the facilities still would require very much less space and very much less installation and maintenance cost than do present airports.

With this type of landing area for feeder airline use, and with the properly designed aircraft to fly from it, Southwest Airways is positive that the time lost per landing on the two feeder systems for which it already has made application to the Civil Aeronautics Board (11 routes in the three Pacific Coast states and 20 routes in the Texas area) could be cut down to an average of 5 min. To the best of our knowledge, that is the only way feeder airline schedules could be flown fast enough to render adequate service.

As a practical matter, no feeder airline will be able to require that communities along its routes put in landing strips immediately. It will have to take whatever facilities are available, using airports already established when landing for passengers.

But in a short period of time, it is probable that some of the towns will realize the advantage of separating their feeder airline traffic from that of the private owner and other local flying, due to the difficulties and hazards involved in trying to get scheduled flying through their limited airport facilities with a minimum loss of time. When this realization is reached, landing strips probably can be established.

In the case of those communities which now do not have airports but which desire passenger service on a feeder line system, it seems likely they will start out with a landing strip. Then, if there is sufficient need for more extensive facilities, an airport can be constructed.

However, dependence upon the communities themselves to take the initiative in establishing strips may well involve a considerable number of years, during which feeder airlines would not be able to perform their complete function of mail, express, and passenger service. Most small communities are hesitant to plan building air facilities, for they have seen too many of their neighboring cities burden themselves with heavy bond issues to finance the immense airports presently required.

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We think the most logical way to launch landing strips where they are needed by feeder lines would be to make them part of either a national or state highway program, or to establish a department of the Civil Aeronautics Authority which would provide them as aids to navigation. Undoubtedly some method of local participation in the program could be worked out if desired; perhaps a town wishing a strip could pay part of the construction cost and the governmental agency the balance.

There is no question of the success of strips. Those built for wartime military purposes have proved so successful that Fred E. Schnepfe, special engineering consultant to the administrator of the Federal Works Agency and director of the Public Roads Administration's flight strips division, recently said this of strips built under authorization in the Defense Highway Act of 1941:

"They have justified everything we expected them to do From operational and engineering standpoints they have proved entirely feasible and distinctly successful, particularly considering that these facilities are built at a cost so much less than an airport."

Schnepfe predicted that landing strips would have an important place in postwar civil aviation, stating that "for routes which are sure to come at the close of the war . . . bringing complete air service to as many as 5,000 communities, compared to the less than 500 cities receiving some kind of air service at the start of the war . . . the installation of flight strips will be the wisest course to pursue in providing landing facilities for these communities."*

There are approximately 8,000 cities and towns in the United States with a population of more than 1,000 people, a size of community which the All American operation has proved it is feasible to furnish with air transportation. Of course not all of these will be served by feeder routes, but we believe that within four or five years some 6,000 communities should have the benefits of direct air service.

Probably at least half of these would require no landing strip but would be served by mail and express pick-up alone. This would leave some 3,000 landing strips needed to expedite feeder airline schedules. The sooner this proposal can be incorporated in some national plan the better.

For here, again, construction of landing strips would provide a lot of jobs for our boys when they come marching home. It also would firmly assure the future permanence of widespread feeder airline operations, keeping our nation's air transportation system the most complete and progressive in the world.

---

* Readers are also referred to Flight Strip "Hows" and "Whys", p. 247, Jan. AVIATION.

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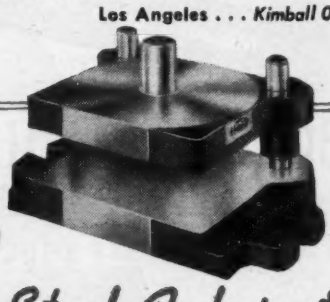

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America at War

(*Continued from page* 113)

Results already produced by the Nazis in their war of defense are improved fighter performance, heavy new armor in exactly the right places to protect their pilots while they are making passes at our bombers, and more 20 mm. guns. Their airborne bomb catapult is an effective weapon. It throws a powder charge bomb with compressed air.

There is some trustworthy opinion that German pilots' morale is cracking as they see more and more Allied bombers coming despite their struggles. But other opinion, just as trustworthy, says we cannot be too sure of that.

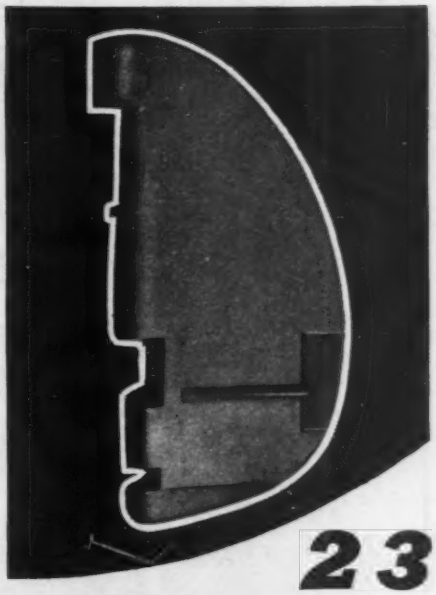
As time goes on the Germans put more and more of their industry under ground or hide it with increasingly effective camouflage. Allied crews have tried to skip bombs into subterranean works, but obviously this is a difficult thing to do. At the same time, Allied forces advancing north in Italy hasten the day when all Germany and all her captives will be in range of attacking aircraft. We have already reached Poland and Prussia in the far northeast, although not with maximum bomb loads. Full-load bombing is still limited to 500 or 600 mi.; beyond that too much of the load is fuel.

The Army is shifting emphasis to long-range fighters. This means, for the present, important changes in some planes and discontinuance of others. The P-38, which has the longest reach of any U.S. fighter, probably can be made to range farther. P-47's appear to be in the same league, escorting the heavy bombers on constantly longer raids. You can guess for yourself that the much-praised P-51 will have its range stretched.

In addition to long-range fighters, the Army wants heavier production of the B-24 *Liberator* and of the B-17 *Flying Fortress*. These planes can hit all parts of Hitler's shaky empire from bases soon to be available. But the new B-29 super-bomber is being rushed to maximum production to do a still heavier job; its range will be nearly double that of its predecessor.

It is hard to be certain of anything on the Russian air front. Beyond doubt the Allied attack in Italy and across the Channel has pulled a load of German fighters off the Muskovites' backs. Soviet airplane production is going up, with some estimators (who know very little about it) putting the figure at 1,900 per mo. That alone would be enough to tie up all the air power the Germans have to spare for their eastern front if, as is reported, the Russian quality is good.

One hesitates to call anyone an au-



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thority on Russian arms. We remember too well some of the "authoritative" miscalculation that the Reds would last three weeks against the Germans. But our authorities, such as they are, think the Russian winter campaign will put Hitler approximately back on the very line from which he started the invasion—the boundary of Germany. And most people think the Russians won't stop there. On the other hand, some people do express apprehension that the firing might cease, releasing German fighters for action on the Western front.

On the other side of Russia, the Allies want bases from which to bomb Japan—the subject comes up more and more frequently. Sen. "Happy" Chandler, who recently returned from the Pacific theater with four other Senators who were on an inspection trip, says that the use of such bases would save one million lives on our side. We suppose we might expect the Russian argument that a full-blown second front in Western Europe would save millions of Russian lives. Then again, a tremendous amount of set-up and supply necessarily would have to precede use of such Pacific air bases. Moreover, the consequent business of Russia going to war with Japan must be considered—in short, a weakening of the Russian effort against Germany at a time not suited to the "beat the Nazis first" program.

Incidentally, if you wonder why the Reds don't talk, here is perhaps the best explanation you will find. They are ruled by a dictator, and what he says goes. But our government is different. No man here can say "what goes," not even President Roosevelt, though his war powers seem great to us. The Russians remember that President Wilson sold the world a league of nations, but he didn't sell it to our Senate. They know that Mr. Roosevelt does not have final authority, that he cannot make a deal for us and guarantee it.

About the bombing of Japan—trouble there, too. First, look back a year or two. The aviation "experts" and the fans over-extended themselves on the possibilities of air power. They figured right on the damage aviation can do to an enemy, but they far underestimated the things that have to be done before aviation can take off. They didn't dream of the amounts of supplies, ships, docks, roads, airports, warehouses, housing, hospitals, foods, medicines, and men it would take to back up a strong air task force. Most of them admit it now. That is why it is so much harder than we thought to make mince meat out of Germany.

How much harder, then, will it be to crunch Japan, which is so much far-

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So writes an American pilot from the Southwest Pacific. This statement aptly expresses the finest tribute that can be paid the American combat planes. It is a reflection of the determined and continuous efforts of plane and accessory manufacturers alike to provide ever better performance, greater safety and more dependability. Reports of aerial combat in the various theatres of war show the definite superiority of American planes.

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For years, VARD has built precision aircraft parts and gages, but few pieces of aircraft equipment which we have built top this small transmission for critical accuracy. Despite its small size, it handles an unusually high load through a forty-five to one gear reduction. The unit contains chain sprockets, a worm and a worm gear and zerol bevel gears, all carried on ball bearings. Tolerances are at a very minimum, as there can be no slack in the whole transmission system.

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ther away. On the favorable side of that picture, as these writers have said before, is the enormous amount of airplanes and all it takes to back them up, including veteran crews, which will be released when the Nazis fold. But it will be a long hard job to get set for the punch. Any layman with a map can see that there are about four ways to do it, and he can see that they are all difficult. Furthermore, the Japs, being resourceful in war, will give us a run for our money. Already they have thought of moving their vital industries into Manchukuo, the size of the United States east of the Mississippi.

Allied invasion of Italy, the capture of Foggia and Naples, and the drive on Rome all made a pretty picture. The informed military men knew that the Germans had orders to retreat after their initial failure at Palermo. Best thing about it was the magnificent air support of our ground forces. Gen. Arnold said we couldn't have taken the beachhead without it. People who saw it, said Allied air support cut a swath like a scythe. First the Germans and now the Allies prove that ground forces with air superiority overhead cannot be licked. That's why the Army demands more and still more from the aircraft industry; and the demands are for it all this winter.

In the Pacific, the capture of Lae, powerful Jap base, and the taking of Finschafen were both serious blows to the Japanese. They see plainly now that the Allies mean business and can give them a workout whenever they want it. So they, too, are on the defensive. And they are shifting their aircraft production to fighters, just as are the Germans. They know they cannot take any more territory.

But, as President Roosevelt says, they are holding an empire that reaches from Paramushiro down to China, the East Indies, Malaya and Burma. He says we shall have to hit them hard in many places.

Our aviation industry here in this country is on a production plateau, around 7,600 per month Manpower shortage and design changes, the two main bottlenecks, are an old story by now. Worst part of it is that all the apparently possible answers have been thought of, and nobody knows which one, or which combination, will do the trick. There is no more new manpower to be had, and it looks as if workers will have to be shifted from other war and civilian production to airplanes.

At last some official words have been said on the postwar international airline policy of the United States. The words came from no less than President Roosevelt himself, who says he is in favor of private ownership and operation—in favor of freedom of the air to

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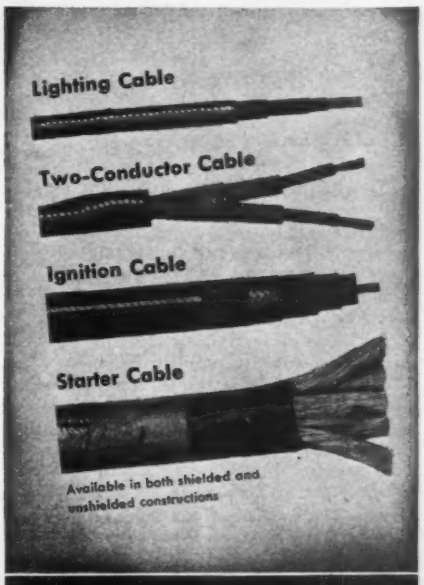

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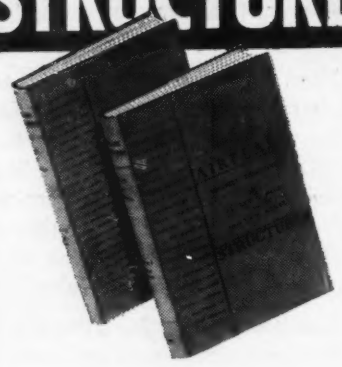

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the extent that the lines of one country could pass over another by permission. He is probably in agreement with the interdepartmental committee on air policy. And the group of 16 airlines which recently declared for free competition over the seas was pleased with what he said. Of course, agreements still have to be reached with England and other countries, and probably the Senate will want to pass upon them.

The Civil Aeronautics Board has opened hearings to obtain information on which to base future award of so-called "feeder" airlines which, it is expected, will network the country. The evidence indicates a huge volume of business awaits those carriers which can cut costs and beat the trains and autos on short runs. Specially designed airplanes may give the needed economy, but nobody knows what to do about cutting the time from the passenger's door to the place where the plane takes off.

Plant Power—Minus the Bottlenecks

(*Continued from page* 159)

breaker, and a varying number of load breakers in each switchboard. By means of the station tie and by-pass breakers, any plant substation can be (1) operated as an individual load center, (2) connected to one or two other substations or (3) cut out entirely.

Just as a complete plant substation can be transferred to either of the master substation buses, so can the loading of power transformers in each substation be obtained by relying on the interconnections of the secondary power buses through the station tie breakers at the substation, or by closing or opening sectionalizing points in the low voltage bus duct runs between heavily and lightly loaded adjacent substations.

That a high degree of flexibility exists in the power distribution system is proved by the fact that all unforeseen rearrangements of machines in production lines and shifts of load concentrations have been accomplished with no major changes in the original installation. As an example of the flexibility of these interconnections to take care of future expansions, eleven new substations have been added to the original ten either by connecting them to existing feeders or to new feeders, all without loss of production anywhere in the entire plant.

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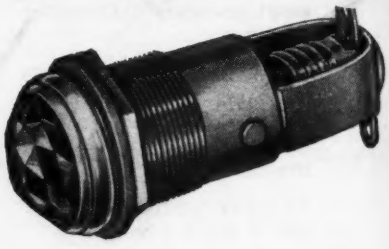

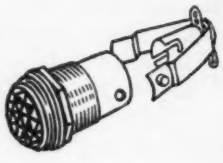

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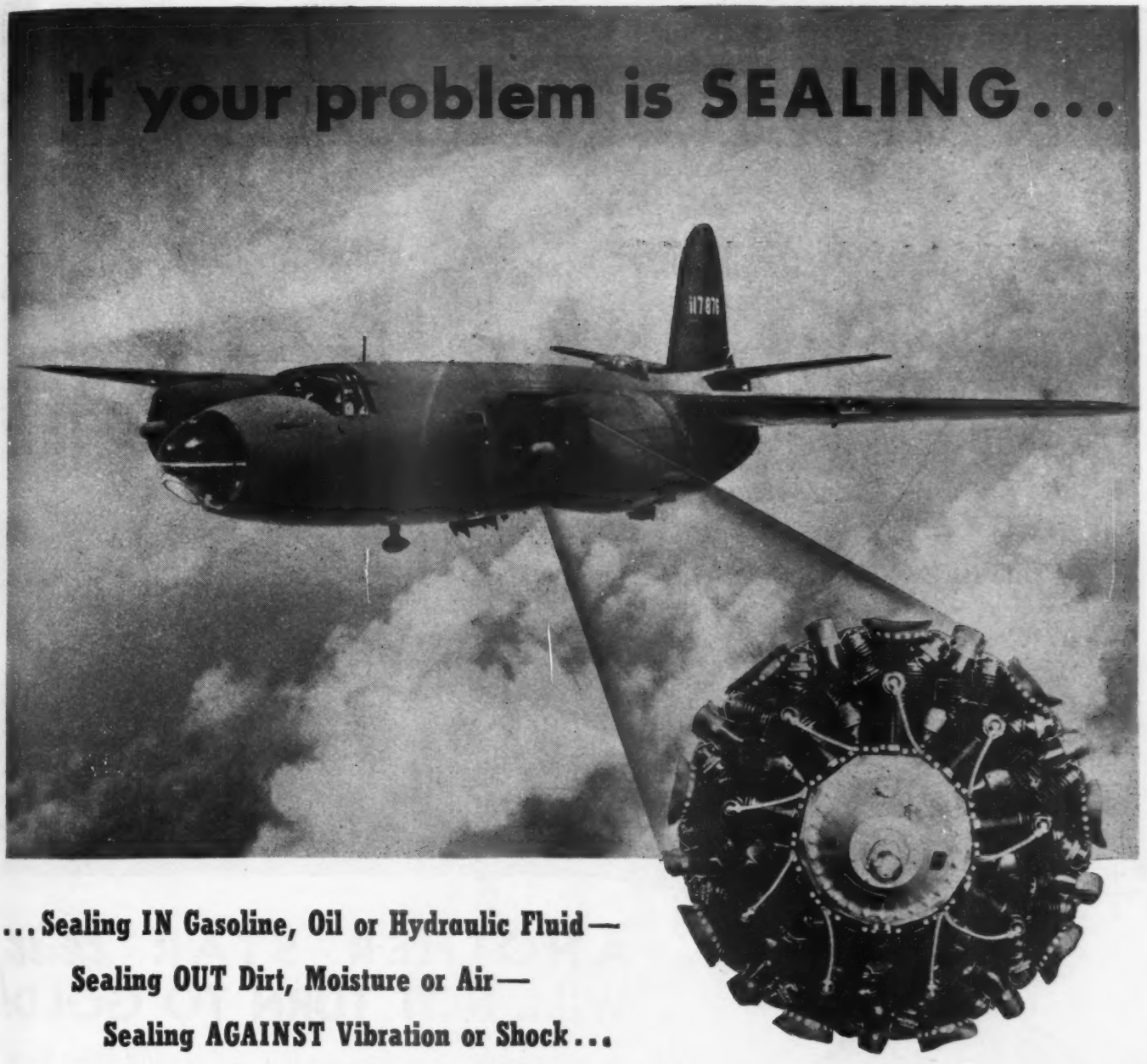

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formers. Each switchboard has two network protectors and two station tie-breakers. There is variance only in the number of load breakers.

Since lighting is considered a service of prime importance, lighting transformers have their secondaries extensively interconnected. A plant network for lighting is considered the best so far available, since such a load is stable and fixed and this system offers the highest degree of reliability and the best voltage regulation.

The lighting network system used in this plant was designed to supply service to the lighting bus at each plant substation and not to protect service to outgoing feeders. For this reason the plant substations are normally operated as individual lighting buses; that is, the station tie breakers are normally open. By closing the tie breakers it is possible to connect two or more lighting buses together to supply a substation in trouble or to form a complete loop if desired.

For example, in one large building there are six plant substations each with its own lighting bus These may be operated as separate buses, all six connected in a complete loop, or with any two or more buses tied together. Thus each large building may have its individual network loop for lighting.

Since lighting buses can be connected in a loop, network protectors are installed on the incoming circuit from the secondaries of the lighting transformers. This differs from the power system, because it is not planned to connect the substation power buses as a loop system.

Lighting transformers are customarily loaded close to their full capacity. A 500 kva. 3-phase transformer is found to be the preferred rating, for a load of this size can be safely carried by the other transformers in an emergency.

Fluorescent lighting was used because a maximum area could thus be served with a given size transformer due to the low wattage per square foot required for this type of lighting.

Once the area that could be served by a 500 kva. lighting transformer was determined, it was a question of adjusting the power load in the same area so it could be accommodated by moderate size transformers. In this case, 750-kva. power transformers were found to be the most economical when the investment for low voltage switchgear and interconnections was balanced against the number of plant substations required.

This standardization of sizes and voltages of power and lighting transformers permits the ready replacement of a faulty transformer. The 3-phase transformers give the same reliability as banks of single-phase transformers because of the extensive interconnections of the secondary mains. The 3-phase

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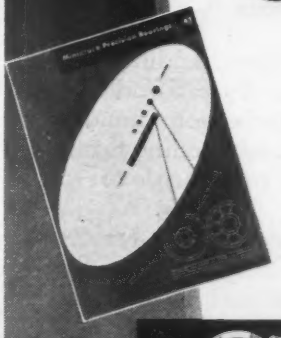

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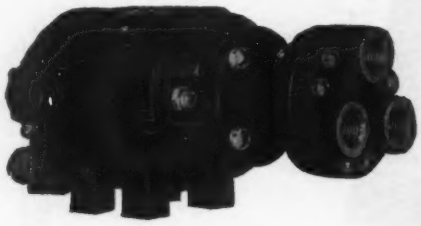

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units also consume less in floor space.

It will be noted that high voltage metal clad vertical lift switchgear and low voltage distribution switchboards with draw-out air circuit breakers are used throughout the plant. By the use of spare breakers, a breaker which has failed or requires maintenance can be removed completely from the switchgear and taken to a location where easier access to all parts of the unit can be had.

The features of this distribution system were worked out through cooperative efforts of Wright Aeronautical Corp., Albert Kahn, Inc., and Westinghouse engineers.

Cancellation Demands Action—And Quick

(*Continued from page* 119)

set up a full time organization made up of accounting, plant engineering, storekeeping, manufacturing, and legal personnel to handle all aspects of the contract termination. The Ordnance Department did likewise. But five months later the settlement was still pending, and discussions of profit or loss still had to be only in "general terms."

Yet another case is Hazeltine Electronics Corp., which received an abrupt cancellation order in June, 1942, only about two months after receiving its letter of intent on a contract. Payment had not been received 14 mo. later although there had been "reams of letters, telephone calls, and telegrams." On one occasion during negotiations the company received word from one of the many men who had handled its claim that his department was interested in getting production and not in settling claims.

A New York State manufacturer of boring mills produced two units on a contract and then, more than six months ago, had the contract cancelled. It will be several more months before full payment is made on the deal.

The list of such cases could be greatly expanded.

WPB has been engaged for more than a year in drafting a uniform cancellation clause to be incorporated in all fixed-price supply contracts. This worthy project has, however, had only lukewarm support from other government departments and agencies. The latest proposed draft was submitted to industry for suggestions, and if finally adopted it will be incorporated by reference in fixed-price contracts. The WPB also expects to draft uniform regulations for cost-plus-fixed-fee and emergency plant facilities contracts.

Meanwhile, however, the WPB plan has run into difficulties. The general accounting office, it seems, was by-passed in the WPB efforts to speed up termina-

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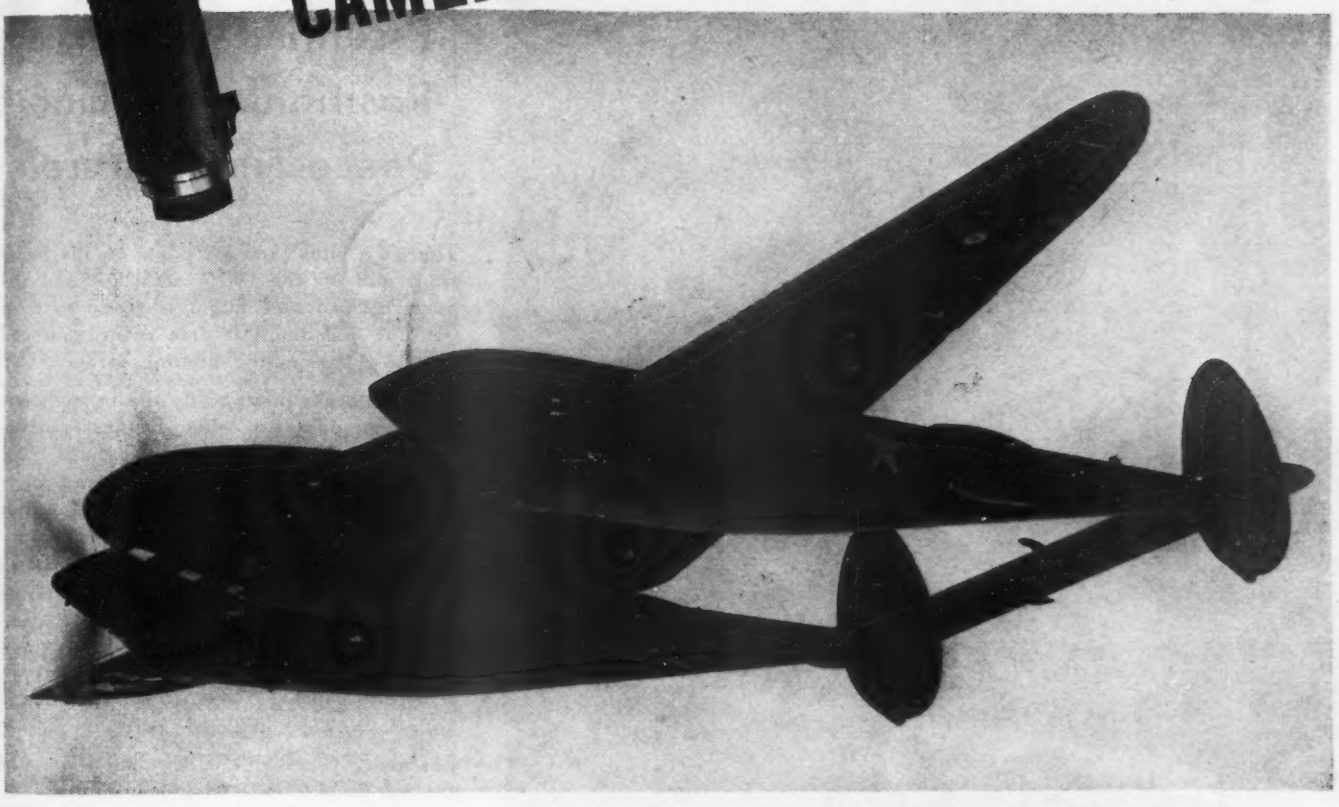

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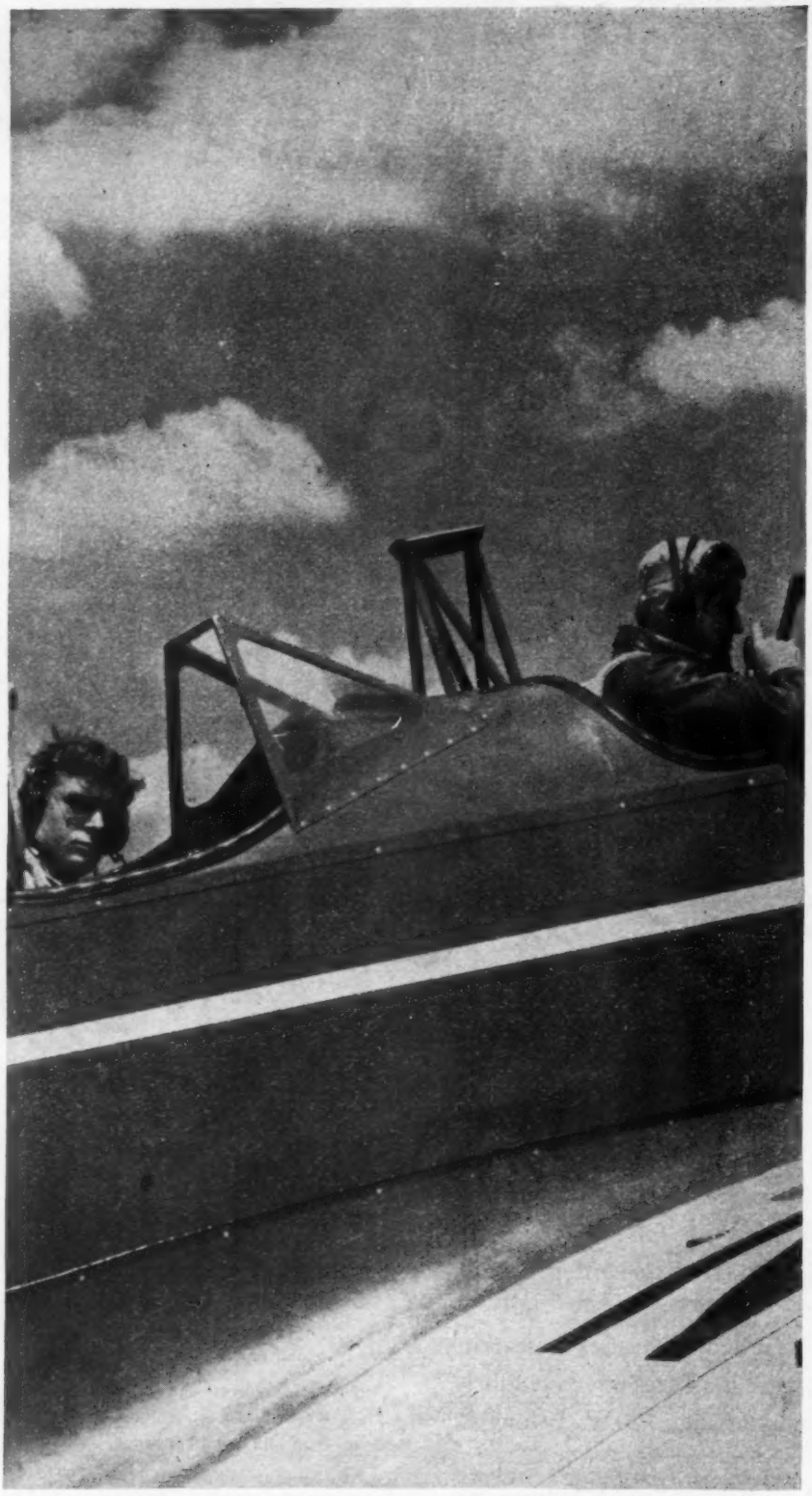

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tion. Comptroller General Lindsay C. Warren therefore has entered the lists by asking Congress to enact legislation making the GAO, over which he presides, the final arbiter of all claims arising out of cancelled contracts.

Thus the Washington inter-agency battle for power now extends even to termination. And what's more, Congress very likely will back up Warren, since he is solely responsible to that august body. Warren would have the GAO review all claims and "certify for payment such balances as it may determine to be due." Such audits would take time, and it may well be that time will be more precious than money immediately after the war.

It is not the writer's intention to infer that the WPB proposal eliminates the need for legislation. Quite the contrary. In the first place the legality of this proposed formula which allows cost-plus-a-percentage-of-cost has been questioned in legal quarters. The First War Powers Act of 1942, it is pointed out, carries a restriction that "nothing herein shall be construed to authorize the use of the cost-plus-a-percentage-of-cost system of contracting."

The WPB plan also does not jibe with damage rules laid down by the federal courts. Further, it provides for appeals boards whose personnel might be chosen entirely from government departments and thus make their impartiality open to question. The same War Powers Act provides that contracts can be amended to include provision for negotiated settlements in terminations where such action is taken "to facilitate the prosecution of the war." However, the legal point has been raised whether or not this provision could be applied to contract termination after the cessation of hostilities.

Congress should recognize, then, that the First War Powers Act, rushed through just after Pearl Harbor, was only temporary legislation and that new laws are needed to make settlements that are binding and final.

The highest court has ruled that a company's expenses incurred in an effort to keep solvent or to regain its peacetime markets after cancellation cannot be recovered from the government. Here, it would seem, is another matter for Congress to look into.

The chief of one of the departmental price adjustment boards recently was asked what would happen to inventories when the war was over and contracts were cancelled. That, he replied frankly, was a big problem that hadn't yet been solved. Yet it is one of the most vital considerations of all.

Today, the government owns over one-half of the aircraft industry's inventories, and a large proportion of the remainder has been purchased with government funds in the form of con-

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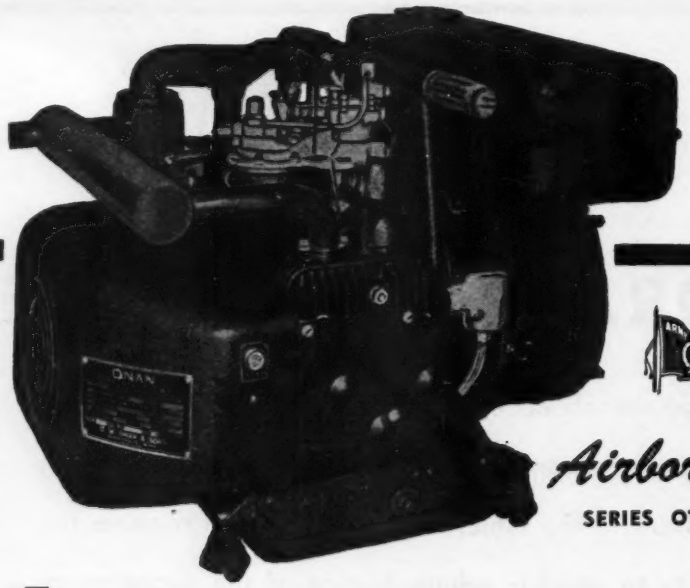

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tract advances. As long as Uncle Sam continues to buy all the industry's production, enough cash can be secured to meet running expenses and the war effort will not suffer. Government, it is expected, will accept responsibility for materials specified in the contracts it cancels.

But what of the inventory that cannot be directly traced to a cancelled contract? Every aircraft plant has invested a big share of its so-called profits in stockpiles of all kinds of materials and parts. Huge inventories are an absolute necessity in an industry dealing with more than $15,000,000,000 worth of contracts whether orders are at hand covering such accumulations or not. Otherwise production would bog down at a crucial moment when some supplier's plant is struck or some other contingency arises—as has so often happened in the past and will continue to happen in the future.

An 11 percent decline in the inventory of the average large plane maker would exhaust its working capital, according to a survey made by the Harvard School of Business. And such a decline in inventory values is not only possible but probable after the war. What, then, will be the inventory values of war materials when the fighting stops?

Here is what happened to $1,400,000 worth of cutting tools out in Detroit a short time ago: The whole 110 tons of them were sold for $75,000 when a change in aircraft engine specifications was said to have rendered them obsolete. Semi-finished and finished parts by the hundreds of thousands will suddenly become a drug on the market, since only about 20 percent of the industry's inventory is in raw materials. Most of this inventory will thus have to be sold for scrap.

In the case of cost-plus-fixed-fee contracts the plane maker has no primary responsibility for the inventories. But as Ralph S. Damon, American Airlines vice-president and former president of Republic Aviation Corp., recently explained before the House Naval Affairs Committee, the industry has no clear-cut picture of the amount of government inventory on its hands. Often, he testified, design changes have been made in supposedly "frozen" planes so that, overnight, companies have had to scrap large amounts of government inventory which have been lost in the shuffle since then.

Thus Congress must provide some form of inventory protection, otherwise inventory losses alone may easily wreck this essential American industry.

In the meantime, plant procedure which will assure quick and accurate checkups on government contracted materials is a "must" for the industry. War Department officials assert that it takes

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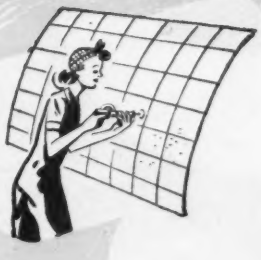

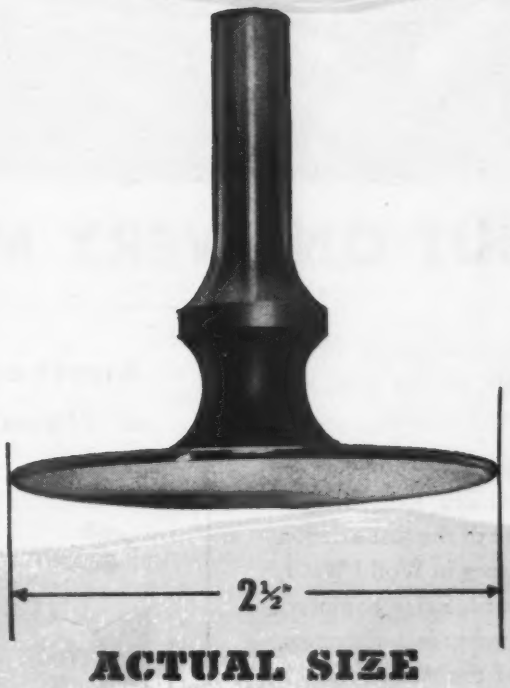

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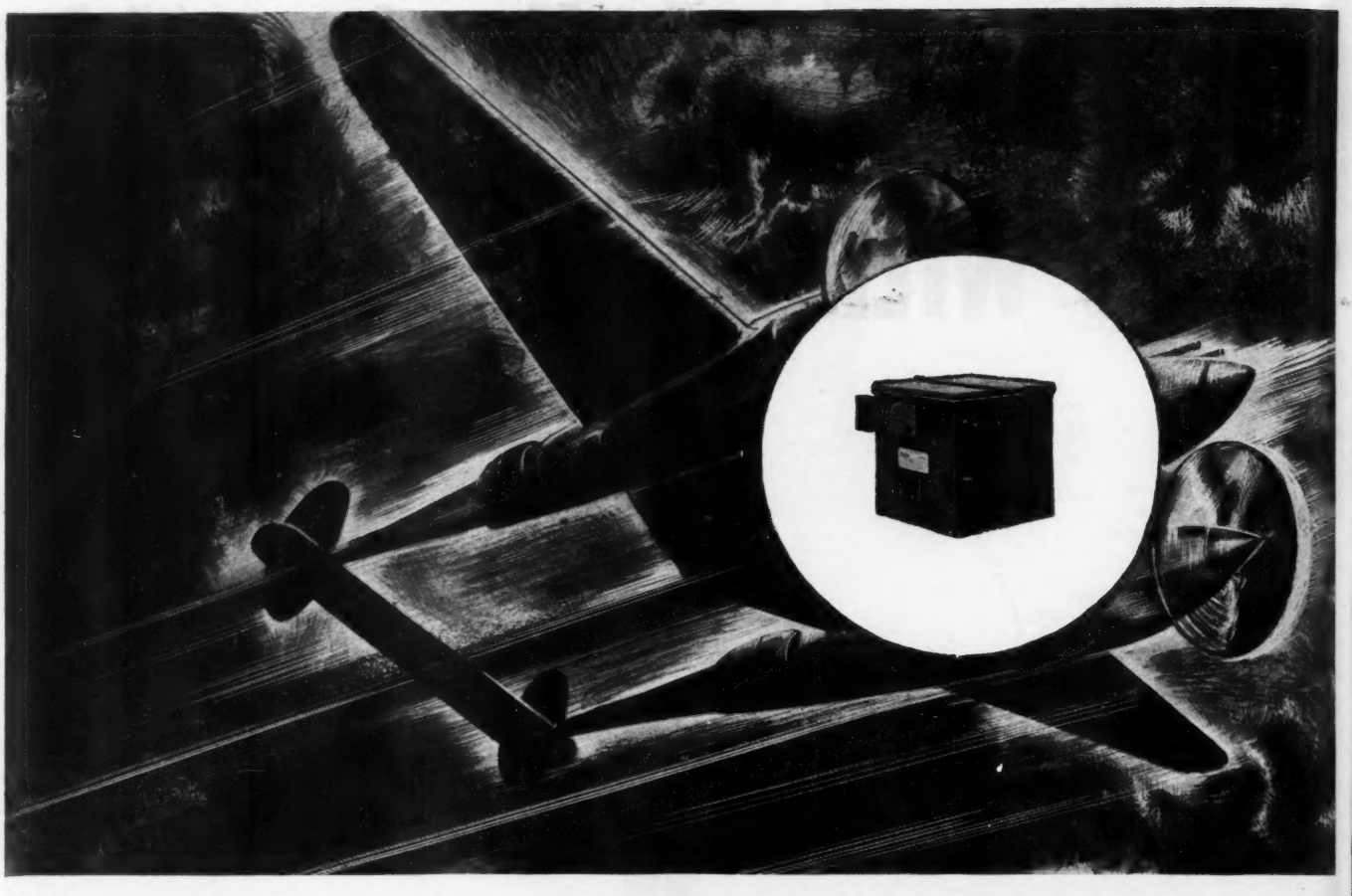

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the average contractor 4½ mo. to get his claim data together. In many cases inventories are believed to be increasing even though unfilled orders are static or are increasing at a much reduced rate. The Controlled Materials Plan should have reduced the amount of inventory held in such cases, but it is doubtful if all manufacturers have taken full advantage of CMP.

Regardless of what may be done to clarify the picture, personnel must be trained to handle inventories of terminated contracts and to devise the proper forms, procedures, and instructions necessary to obtain itemized schedules of supplies, subcontractors, stocked materials, and work in progress. Purchasing systems also will have to be reviewed to make sure new inventory is not in excess of needs.

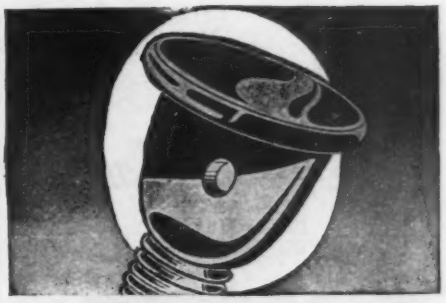
So, despite the best efforts of WPB to arrive at uniform termination rules and procedures, Congress alone can bring order out of the present confusion. There is (1) the status of the general accounting office to clarify, (2) creation of an impartial court of claims to which prime contractors and subcontractors may turn when necessary, and (3) passing of enabling legislation to relieve contracting officials of individual liability for settlements subsequently considered excessive.

There is a desperate need for mandatory legislation to free the money tied up in war work upon cancellation. Unless some liberal method is promptly devised, all other plans of the aircraft industry for its peacetime reconversion will be of little avail. Advance payments of as much as 90 percent are needed. Spokesmen for other industries that are in much better financial shape to weather termination are asking for no less than 75 percent immediately on their verified claims.

Prime contractors also would like to have the government settle all subcontract claims above $25,000, thus obviating the necessity for the industry to deal with hundreds of termination supply claims. Severance pay for employees is another nightmare. With this, Congress alone can cope—for certainly an industry whose liquid assets are sufficient only to meet a two weeks' payroll can't be expected to.

Then there are the questions of: One over-all claim regardless of the number of contracts involved; one department negotiating for all the government departments involved; legislation to legalize defective contracts undertaken in good faith; reimbursement for termination expenses; and the salvaging of surplus equipment.

Aircraft officials would like to know whether the large or small companies are to have their contracts terminated first and whether contracts are to be terminated immediately after the war



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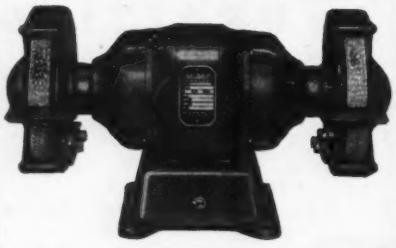

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or if a "tapering off" policy will be followed.

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Practical Congressional action, which is essential to solution of these pressing problems, is certainly deserved by any industry which has turned out as excellent a job as the aircraft and engine producers.

Analysis of Moments of Inertia

(*Continued from page* 154)

into evidence the following characteristics of the member:

1. *Fixed-End Moments.* If a member is so restrained that the ends do not rotate and its relative deflection is zero, the resulting end moments are called fixed-end moments. These moments will be represented by m_{12} and m_{21}, exerted upon ends 1 and 2, respectively. Their expression may be found by making $\omega_1 = \omega_2 = R = 0$ in equations (13); thus

$$m_{12} = \frac{Al\,(b_2 - a_2)}{C\,(c_2 - b_2)}\,,\; m_{21} = \frac{Al\,(c_2 - a_2)}{B\,(c_2 - b_2)} \qquad (14)$$

2. *Stiffness.* This may be defined as follows (Ref. 2): Stiffness is the moment at one end of a member necessary to produce unit rotation at that end when the other end is fixed, it being assumed that the member is not loaded and that $R = 0$. Therefore, making $A = 0$, $\omega_1 = 1$, $\omega_2 = 0$, $R = 0$ in the first of equations (13), the resulting M_{12} is the stiffness at end 1; denoting it by S_{12},

$$S_{12} = \frac{l\,b_1}{C\,(c_2 - b_2)} \qquad (15)$$

$$\text{Similary, } S_{21} = \frac{l\,c_2}{B\,(c_2 - b_2)} \qquad (16)$$

3. *Carry-Over Factors.* These may be defined as follows (Ref. 2): If one end of a member is rotated while the other end is held fixed, the ratio of the moment at the fixed end to the moment producing rotation at the rotating end is called the carry-over factor at the rotating end. It is again assumed that $R = 0$ and there are no superimposed loads. Therefore, the ratio $\frac{M_{21}}{M_{12}}$, obtained from equations (13) in which A, ω_2 and R are made equal to zero, is the carry-over factor at end 1, designated here by c_{12}; thus

$$C_{12} = \frac{C.\,c_1}{B.\,b_1} \quad \text{or} \quad c_{12} = \frac{b_2}{b_1} \qquad (17)$$

because of (12). In the same manner,

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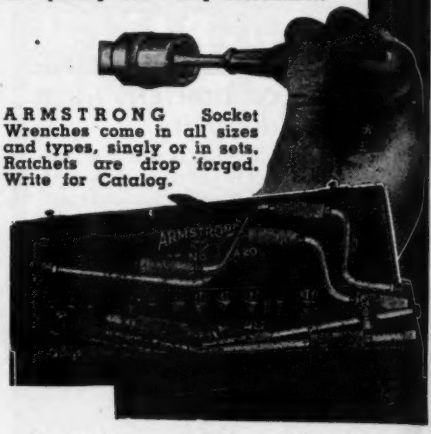

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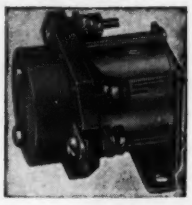

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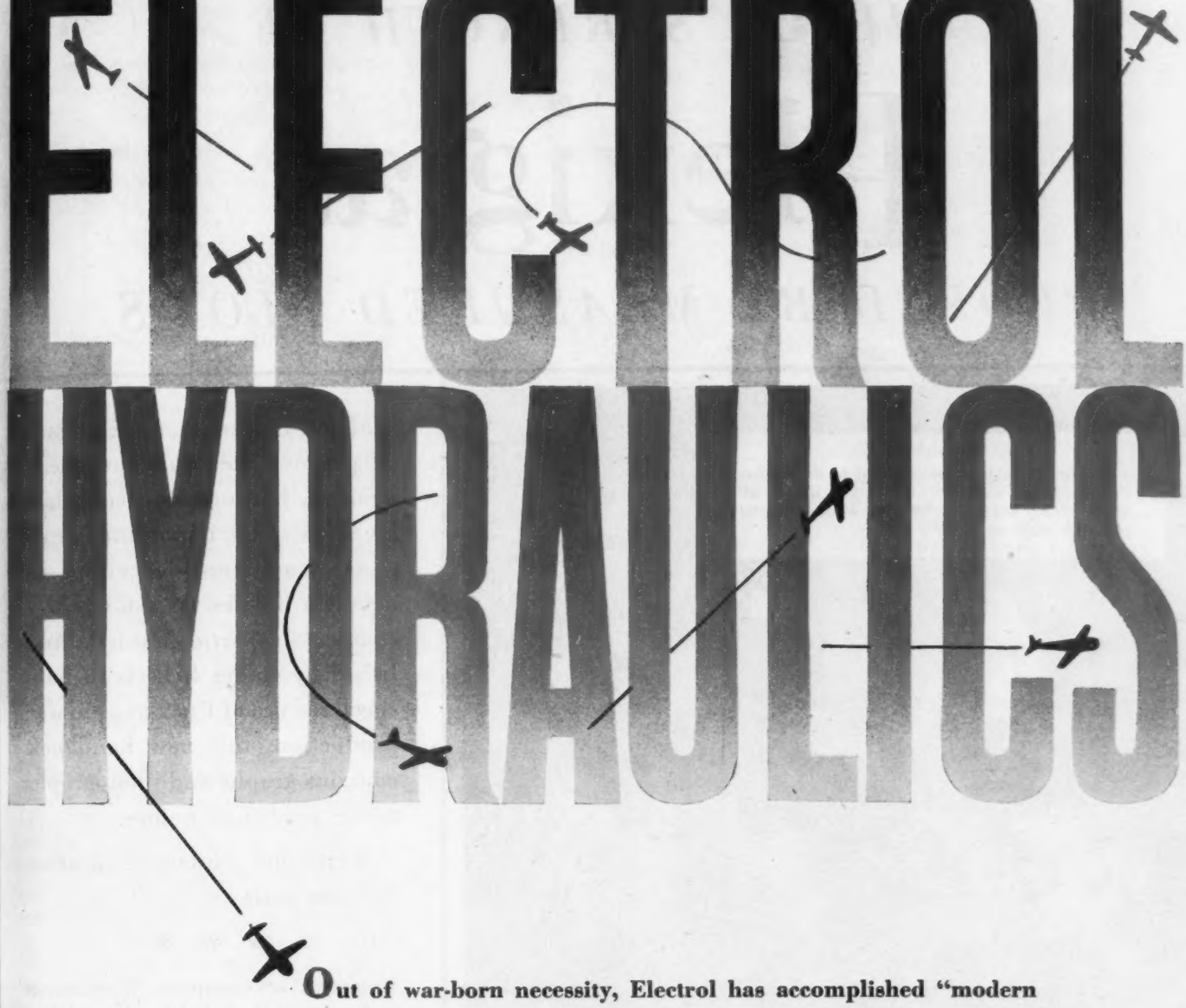

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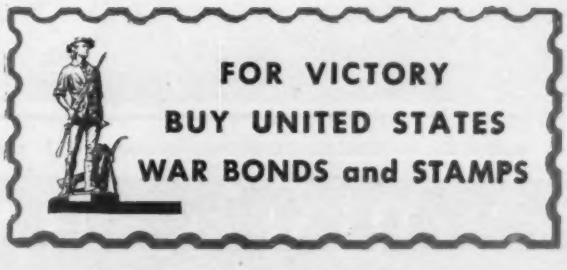

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the carry-over factor at end 2 is:

$$c_{21} = \frac{c_1}{c_2} \qquad (18)$$

The following self-evident relation may be useful for checking:

$$c_{12}\, S_{12} = c_{21}\, S_{21} \qquad (19)$$

Equation of Three Moments

Using relations (14) and solving equations (13) for ω_1 and ω_2

$$\omega_1 = \frac{C}{l}\Big[(M_{12} - m_{12})c_2 - (M_{21} - m_{21})c_1\Big] + R$$
$$\omega_2 = \frac{B}{l}\Big[-(M_{12} - m_{12})b_2 + (M_{21} - m_{21})b^1\Big] + R \qquad (20)$$

If member 1-2 belonged to a string of continuous beams, this member and the adjacent one, 2-3, would both rotate through the same angle at joint 2; the rotation at this joint, considered belonging to member 1-2, is given by the second of relations (20); the rotation at the same joint, considered belonging to member 2-3, is obtained by the first of these relations, applied to this member. Using prime numbers to indicate member 2-3 and equating both expressions of the rotation at joint 2, the following relation is obtained

$$\frac{B}{l}\Big[-(M_{12} - m_{12})b_2 + (M_{21} - m_{21})b_1\Big] + R = \frac{C_1}{l}\Big[+(M_{23} - m_{23})c' - (M_{32} - m_{32})c_1\Big] + R \qquad (21)$$

Because of continuity, $M_{21} + M_{23} = 0$; also, in conformity with sign conventions universally used in the equations of three moments, moments over supports will be considered negative if they result in tension in the upper sides of members; therefore, M_{12} will be replaced by $+M_1$, M_{21} by $-M_2$, M_{23} by $+M_2$, M_{32} by $-M_3$, m_{21} by $-m_{21}$, m_{32} by $-m_{32}$. Relation (21) then takes the following form:

$$M_1\frac{Bb_2}{l} + M_2\left(\frac{Bb_1}{l} + \frac{C'c'}{l}\right) + M_3\frac{C_1c_1}{l} = \frac{B}{l}\left(m_{12}\, b_2 + m_{21}\, b_1\right) + \frac{C_1}{l_1}\left(m_{23}\, c_2' + m_{32}\, c_1'\right) + R - R' \qquad (22)$$

This is the general equation of three moments representing a relation between the moments at three consecutive supports in a series of continuous beams.

Case Application

The formulae derived above will be applied to the particular case of a beam with uniform I and constant E. It will be assumed that the loading consists in a uniform load of w lb. per ft.

For this case, m/EI is represented by a parabola, x/EI and $(l-x)/EI$ by straight lines. As a result

$$a_1 = a_2 = 1/2,\ b_1 = c_2 = 2/3,\ b_2 = c_1 = 1/3$$
$$A = \left(\frac{w\cdot l^2}{8} \times 2l/3\right)/EI = wl^3/12EI, \qquad (23)$$
$$B = C = \frac{l}{EI} \times \frac{l}{2} = l^3/2EI$$

Letting $I/l = k$, the several formulae derived for the general case reduce to the well known expressions:

$$M_{12} = 2EK(2\omega_1 + \omega_2 - 3R) - \frac{wl^2}{12}$$

$$M_{21} = 2EK(\omega_1 + 2\omega_2 - 3R) + \frac{wl^2}{12} \qquad (13)'$$

$$H = -\frac{6EK}{l}(\omega_1 + \omega_2 - 2R) \quad (\text{for } w = o) \qquad (13A)'$$

$$m_{12} = -\frac{wl^2}{12}\ ,\quad m_{21} = +\frac{wl^2}{12} \qquad (14)'$$

$$S_{12} = S_{21} = 4EK \qquad (15)'\ (16)'$$

$$c_{12} = c_{21} = \frac{1}{2} \qquad (17)'\ (18)'$$

$$\omega_1 = \frac{1}{6EK}\left(2M_{12} - M_{21} + \frac{wl^2}{4}\right) + R$$

$$\omega_2 = \frac{1}{6EK}\left(-M_{12} + 2M_{21} - \frac{wl^2}{4}\right) + R \qquad (20)'$$

$$\frac{M_1}{K} + 2M_2\left(\frac{1}{K} + \frac{1}{K'}\right) + \frac{M_3}{K'} = -\frac{wl^2}{4K} - \frac{w'l^2}{4K'} + 6E(R - R') \qquad (22)'$$

(Positive Moments cause tension in bottom fibers)

Illustrative Problem

Fig. 5 represents a twin-boom system forming a rigid frame. Problem: Find deflections and moments at joints due to a force F applied as shown.

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It is assumed that joints 1 and 4 are fully restrained and that the moments of inertia vary linearly between the values shown at the indicated stations. All units are in pounds and inches.

There being no superimposed loads on the members, diagrams A vanish. Diagrams x/EI and $(l\text{-}x)/EI$ for member 1-2 (and 4-3) are shown in Figs. 6 and 7. Fig. 8 represents diagram x/EI for member 2-3; because of symmetry, there is no need to draw diagram $(l\text{-}x)/EI$ for this member.

Following values are obtained by decomposition of areas into trapezoids:

$$\left.\begin{array}{l} B = 83.5/E \quad b_1 = .785 \quad b_2 = .215 \\ C = 41.2/E \quad c_1 = .434 \quad c_2 = .566 \end{array}\right\} \text{(members 1–2 and 4–3)}$$

$$B' = C' = 40.5/E \quad b_1' = c_2' = .672 \quad b_2' = c_1' b_1' = .328 \text{ (member 2–3)}$$

End moments are expressed as follows

$$M_{12} = 373E \times (.215\omega_2 - R) \div (41.2 \times .351) \quad (24)$$

$$M_{21} = 373E \times (.566\omega_2 - R) \div (83.5 \times .351) \quad (25)$$

$$M_{23} = 336E \times (.672\omega_2 + .328\omega_3) \div (40.5 \times .344) \quad (26)$$

Shear in member 1-2 is given by:

$$\frac{F}{2} = -\frac{E}{.351}\left[\frac{\omega_2}{83.5} - R\left(\frac{1}{83.5} + \frac{1}{41.2}\right)\right] \quad (27)$$

Condition $M_{21} + M_{23} = 0$ gives:

$$31.2\omega_2 - 12.65R = 0 \quad (28)$$

Solve equations (27) and (28) for ω_2 and R:

$$\omega_2 = 2.28F/E \quad , \quad R = 5.6F/E$$

Replacing in (24), (25), and (26):

$$M_{12} = -132F \quad M_{21} = -55F \quad M_{23} = +55F.$$

References

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(3) W. H. Weiskopf and J. W. Pickworth, Tapered Structural Members, an Analytical Treatment, with discussions, *Transactions Am. Soc. of Civ. Engineers*, 1937.

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(5) Portland Cement Association, Concrete Beams and Columns With Variable Moment of Inertia, *Bulletin No. ST 41*. (See list of references in this bulletin.)

(6) A. S. Niles and J. S. Newell, *Airplane Structures*, John Wiley, 1938.

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Aircraft Production Analysis

(*Continued from page* 152)

in some instances, two or more assistants may be required. The unit lead planner and his assistants should be responsible for the complete development of the detail procedures.

Upon receipt of engineering production release drawings, production illustrations, and production breakdown drawings, a study should be made to determine a schedule of final assembly for major structural units relative to the estimated assembly time required, jigs and fixtures required, possible manhours applied per unit, major unit priority, minor unit feeder-lines, and minor unit priority. A preliminary stage analysis should then be undertaken, and a thorough study of major and minor unit functional installations should be made in order to determine functional unit installation priority and sequence of assembly (each functional installation unit being considered a basic stage). This may best be accomplished by establishing a card file system of major and minor units, listing all related installation subassemblies for each major or minor unit stage, less those items installed in subassembly, arranging the corresponding unit production illustrations to match for reference purposes, and rearranging both file systems as changes are made.

This preliminary study will establish all unit installation priority and sequence of assembly, preliminary routing, and production control depots or

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Let's Be Calm About the Helicopter

(*Continued from page* 115)

the needs of some specific operation to which it is naturally adapted, that day will mark the true beginning of rotary-wing progress. I have no doubt that progress will be swift and astounding.

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